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Technology Review

Edited at the Massachusetts Institute of Technology

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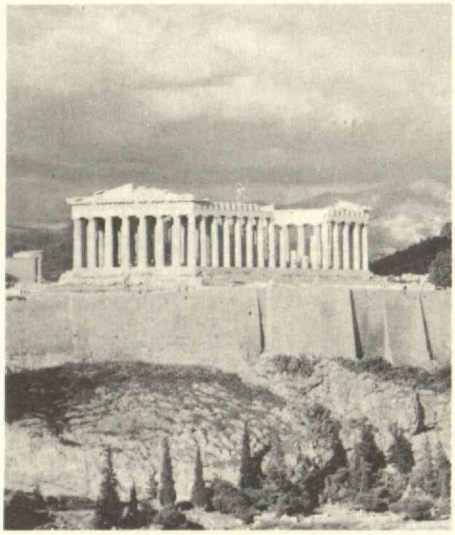

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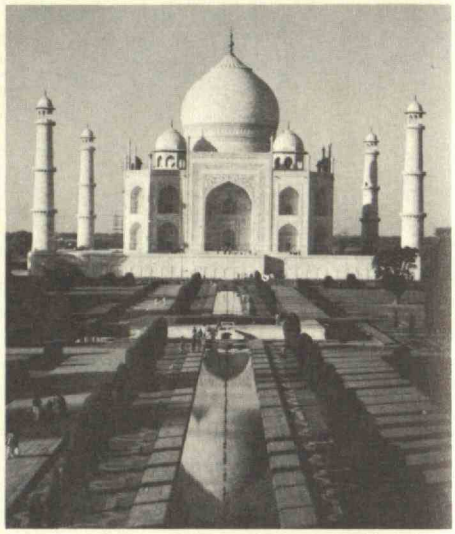

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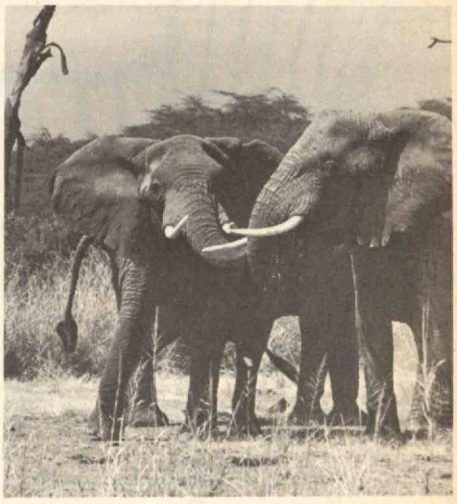

pink flamingos at LAKE NAKURU; multitudes of lion, zebra, wildebeest and other plains game in the MASAI-MARA RESERVE and the famed SERENGETI PLAINS; the great permanent concentrations of wildlife in the NGORONGORO CRATER; tree-climbing lions along the shores of LAKE MANYARA in the Rift Valley, photographing rhino and other big game against the majestic snow-covered background of Mt. Kilimanjaro in the AMBOSELI RESERVE; and the vast and fascinating wilderness of TSAVO NATIONAL PARK, renowned for its elephant and lion and for the unusual desert phenomenon of the Mzima Springs. There is also a stay in NAIROBI, the most fascinating city in East Africa, as well as features such as a visit to a MASAI MANYATTA to see tribal dancing and the tribal way of life. Total cost is $1799 from New York. Optional visits are available to the VICTORIA FALLS, to UGANDA, and to ETHIOPIA. Departures in January, February, March, May, June, July, August, September, October, November and December 1974 (extra air fare for departures in June, July and August).

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Edited at the
Massachusetts Institute of Technology

Volume 77, Number 3
January, 1975

Technology Review

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June, and July/August) at the Massachusetts Institute of Technology; two special editions are provided for graduate (pp. 1-92) and undergraduate (pp. 1-112) alumni of M.I.T. Entire contents copyright 1975 by the Alumni Association of the Massachusetts Institute of Technology. Technology Review is printed by the Lew A. Cummings Company, Manchester, New Hampshire. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: Technology Review, Room E19-430, Massachusetts Institute of Technology, Cambridge Mass., 02139. Telephone area code (617) 253-4872.

Price: $1.75 per copy, $12 per year in the United States, Canada and Mexico, $22 overseas. Please allow three weeks for changes of address, and give both old and new addresses in all requests.

Technology Review is represented for advertising by: Littell-Murray-Barnhill, Inc., 60 E. 42nd Street, New York, N.Y., 10017, telephone (212) 867-3660; Cole, Mason and Deming, 221 No. LaSalle Street, Chicago, Ill., 60601, telephone (312) 641-1254; Zander, Coughlin and Thompson, 5478 Wilshire Boulevard, Los Angeles, Calif., 90036, telephone (213) 938-0111 and 22 Battery Street, San Francisco, Calif., 94111, telephone (415) 398-4444.

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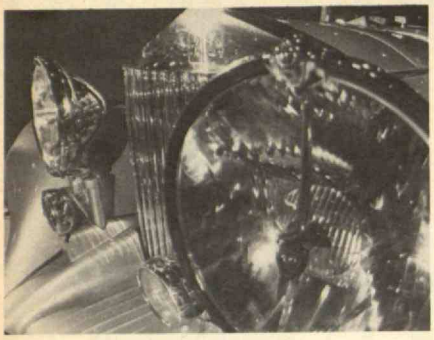


Coming in February:
The 40 m.p.g. Car?
The era of the grand classic (*above*) can never return. But what about motoring in 1980—President Gerald Ford's deadline for achievement of a 40-m.p.g. automobile?

Three articles in our February issue will help you understand the answer:

—The Automobile as an Energy Converter, by J. T. Kummer of the Chemistry Department, Scientific Staff, Ford Motor Co.: a "marked improvement" is possible in the efficiency with which gasoline is transformed from chemical to kinetic energy in automobiles; the result could be "a substantial, though not overwhelming, decrease in our total petroleum requirements."

—Improved Fuel Economy for Automobiles, by Charles E. Cohn of Argonne National Laboratory: simple changes based on near-term technology can help us travel farther on less fuel.

–Reducing the Energy Investment in Automobiles, by John K. Tien *et al.* of the Henry Krumb School of Mines, Columbia University: some options for reducing the energy required to build an automobile will markedly increase that required for its operation. As energy and materials grow dearer, what balance should we seek?

The car in the photograph (*above*) is a 1934 Rolls Royce, one of the outstanding automobiles formerly in the collection of George R. Wallace, Jr., of Fitchburg, Mass. Mr. Wallace studied chemistry at M.I.T. with the Class of 1913, and when his automobiles were sold in a notable auction last summer Mr. Wallace told the press that proceeds would come to the Institute. (The photograph is by David L. Ryan of the *Boston Globe.*)

Letters

Optimism and Myopia on the City?
While it is undeniably refreshing to read two knowledgeable people's account of urban rejuvenation (*"New Directions for Our Cities in the Seventies," June, pp. 10-19*), there is in the article an unreal, irrepressible optimism that undermines all credibility. Ganz and O'Brien relate the history of Boston's decline and recent upsurges in terms of employment, office space, property values, income, and population; and their prognosis reflects continuing optimism. But there is a simplism and myopia in their analysis that makes one wonder if they really exist.

They say, for example, that "office building construction is remaking the downtowns of our large cities," that "office employment is giving rise to downtown residential development." This generalization simply cannot be substantiated: Washington, D.C., for example, is experiencing tremendous growth in office space, but relatively little residential growth has occurred in central city areas. Furthermore, skyrocketing costs for housing in those few livable city neighborhoods make it difficult for anyone other than the rich to live well.

Similarly, the authors' expectations that urban environmental quality will be enhanced through conformance with clean air regulations and development of mass transit systems have little basis in reality. On the contrary, energy shortages have had the effect of undercutting air quality goals.

The authors' list of pollyanna-isms goes on and on. If there have been widespread trends toward limits on high-rise development, provision of amenities, protection of open space, preservation of historic structures and districts, and development of an urban design ethic, I—and many other city planners—have yet to see them. Victories for a quality urban environment are at best sporadic and come only after devastating battles.

But what may be most important in Ganz's and O'Brien's article is its disturbing and pervasive attitude towards the urban poor. Many of the cities' problems are seen evaporating because of reduced in-migration of the poor, because high-paying service jobs are replacing lower-paying manufacturing jobs, because expensive housing is being built. But what happens to the poor who have already moved into the cities, who have been deprived of low-skilled manufacturing jobs, who can't afford urban housing? They are being shunted aside, just as they were shunted aside in the movement to the suburbs of the early 1950s.

What may, then, be happening is that cities are destined to become little more than densely developed enclaves of the rich—suburbia superimposed over the central city. New directions and new hopes for the city imply to me something more than that.

Diana Hope Wahl
Washington, D.C.

What of the Post-Nuclear Future?
There has been a disturbing tendency (in *Technology Review* and elsewhere) to look at nuclear proliferation like this: "The governments of the world, the bastions of civil peace, would crumble under the onslaught of smuggled bombs; the statesman would be checkmated by the lone terrorist; social order would vanish in the face of at best a return to the Stone Age, if not the end of human life. Rational projections must assume that this proliferation will somehow be prevented." So say optimists; pessimists omit the last sentence and make no plans.

For perspective, consider what a futurologist might have said about gunpowder—c. 1550: "The castles of Europe, the bastions of civil peace, would crumble under the onslaught of cannon; the knight would be checkmated by the mere yeoman with a musket; social order would vanish in the face of at best a return to the Dark Ages, if not the very end of Christendom. Rational projections must assume divine intervention to prevent this proliferation."

The indicated development in either case is neither the end of the world nor a return to any prior age—nor least of all a continuation of the status quo. In the present case, I look for small social units (a big city is too juicy a target) with extensive trade (necessary for survival) but no political integration (how bring a nuclear-armed dissident into line?). But these are just conjectures; we need thoughtful, expert studies. We *don't* need any more pollyanna optimism or hand-wringing despair.

Erwin S. Strauss
Silver Spring, Md.

What About Solar Energy?
I find one point to criticize in the position paper on energy from the Policy Study Group of the M.I.T. Energy Laboratory (*"Energy Self-Sufficiency: An Economic Evaluation," May, pp. 22-58*). Nowhere did I find mention of the potential impact in the immediate future of some of the less conventional forms of energy.

I have specific reference to solar energy in all its forms. I think this omission is extremely critical: If one establishes a framework for planning which excludes certain possibilities, then—by definition—they will be excluded in the solution. I am very much concerned that if we exclude solar energy in all of its forms the solution we come up with will be even more painful than those we've seen in the past.

B. J. Luberoff
Summit, N.J.
The writer is Editor of Chemical Technology.*—Ed.*

A Tasty Salad With No Distortion
As I write I'm enjoying a tasty organically-grown salad, and I'm afraid I cannot agree that my "health or health dollars" are being "stolen," as alleged by Stephen Barrett of the Pennsylvania Medical Society (*"Chemicals on the Menu?" June, p. 53*). The seeds cost 39 cents, and the "fertilizer" (eggshells, grass clippings, dead leaves, etc.) would otherwise have gone to the regional incinerator to add to our local smog problem.

The trouble with Drs. Barrett, Arnon, Paarlberg, and Mrak is that they are too busy trying to tear down healthy nutrition and organic gardening and farming to learn what it is all about. We aren't trying to set the clock back 200 years, or go back to the three-field system of the Middle Ages. We are trying to build on what is known, learn more, and correct some of the mistakes that have been made in developing modern agriculture.

"Organic" fertilizers have at least one major advantage: They release nutrients at a rate which does not distort the natural growth processes of the plant. Many chemical fertilizers, if applied heavily enough to maximize crop yield per acre, kill the soil bacteria and earthworms. The drainage from farms where chemical fertilizers are used pollutes the streams and lakes. Mean-

Continued on p. 64

Toward a Theory of Research Grants?

Economics/Society/Technology
by
Kenneth E. Boulding

Last summer Senator William Proxmire made a serious attack on social science research, especially as funded by the National Science Foundation. This seemed to place him in the ranks of the know-nothings, and it caused great distress to those of us who admire him. Nevertheless, Senator Proxmire's criticism raised serious questions as to the needs, priorities, strategies, and findings in this field, and indeed in all others.

We might start off with a very fundamental proposition: We do not know all that can be known, or even all that can be usefully known, about the social system, and we are indeed a long way from this objective. A second proposition is: What we don't know does hurt us. Our ignorance of social systems, and of how to achieve desirable change in them, is at the moment threatening the human race far more than any ignorance in the biological or physical sciences, though our ignorance there is also of great long-run importance. If we are to survive the next 100 years, however, without disaster—either ecological, demographic, political, or nuclear—it is on the social system that we must mainly concentrate. The amount of ignorance that we now have can hardly be defined as "bliss."

A third proposition is that the kind of increased knowledge about social systems which is necessary, perhaps even for the survival of the human race, can only be achieved by applying organized intelligence and truth-seeking—that is, science—to this objective. It will not be achieved by the random thoughts of isolated philosophers or by the hunches of politicians, however important these may be in the absence of real knowledge. There is no doubt a limit to our capacity for increasing knowledge about society in this way, but this limit still seems to be quite far off.

A fourth proposition is that the people who are applying organized intelligence in this way must be funded. A few of them can be supported out of the redundancies of the social system—people who have independent incomes (and there are not many social scientists who do), or people who are supported by what are essentially part-time jobs—for instance, university professors who devote their spare time to social science research. These sources, however, can produce only a fairly small effort; if a larger effort is required, there must be outside funding either from foundations or from governments—from what I have called the "grants economy."

The supply of grants, however, is a function of the perception of the grantors of how efficiently and effectively their funds are or will be used. This is true whether the grants are made out of charity, to increase the welfare of other human beings, or out of a sense of social productivity—a feeling that the product of the grant will benefit society. A charitable grantor who perceives that the dollar he sacrifices will benefit somebody else by $10 is much more likely to make the grant than one who perceives that the dollar he sacrifices will only benefit somebody else 10 cents. In general, the volume of grants which are made for socially productive purposes, in which we can mainly include research grants, will to depend on the perception of their productivity by the grantors. A $1 grant which is perceived as producing a $10 benefit to society is much more likely to be made than one that will only benefit society 10 cents. In the pure theory of grants, indeed, we might postulate that grants should be extended to the point where their marginal social productivity is $1 of benefit for the last $1 granted.

Research on the Inevitable Ultimate Uncertainty

It is easy to state the above principles; it is, however, very hard to carry them out because of our ignorance of the productivity of grant-supported activities. But consider how the same principles may also apply to reducing our ignorance about productivity. Thus we conclude that grants should be made for research on grants until the last dollar expended produces only a dollar of benefit.

Unfortunately, our ignorance can be dispelled only in part. There is a fundamental nonexistence theorem, as mathematicians say, about prediction in social systems, particularly in those involving the increase in knowledge. We cannot predict what we are going to know in the year 2000; otherwise we would know it now. Similarly, we cannot predict the results of a research grant, or we would not have to do the research and there would be no point to making the grant.

There is, therefore, an element of quite irreducible uncertainty in our knowledge about the efficiency of grants. This does not mean that we have reached that irreducible level. One suspects that research on research still has pretty high payoffs. The organizational structure itself leads one to this suspicion. Indeed, the absence of feedback in the grants economy is one of its severe weaknesses. I have sometimes called this "Edsel's Law": if the Ford Motor Co. operating in a market produces an Edsel, it soon finds out; whereas if the Ford Foundation produced an Edsel, it would either never know or would take many years to find out—or it wouldn't even want to know. And the government, after all, as a grantor is just a large public Ford Foundation.

Grantors, therefore, have a tough job, especially the makers of research grants. This is an even more hazardous and uncertain occupation than drilling oil wells. But just as we do not abandon oil-well drilling because we have an occasional dry well, so we should not abandon research grants because some of them do not turn out well. It is the essence of uncertainty that you cannot hit the bull's eye every time.

If indeed we are to develop any kind of theory of making research grants, it will have to be part of the general theory of decision-making under conditions of high uncertainty—a field, incidentally, in which we still need to do much research. It is the absence of good theory in this field that makes the practice of research grants so unsure and open to criticism.

Suppose, however, that the good theory says there can be no theory! Then we have to fall back on strategy—an alternative, I must leave until the next issue.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Global Pollutants

Environment/Technology
by
Ian C. T. Nisbet

One of the greatest environmental surprises of the late 1950s and early 1960s was the discovery of DDT and other persistent chlorinated hydrocarbons in remote parts of the world. The first important hint came with the finding of substantial quantities of DDT and DDE in cod liver oil, derived from fish caught in the open sea. This was followed over the years, by successive reports of these chemicals in seabirds from oceanic islands, in falcons and eagles from remote mountains, in Atlantic salmon and Pacific tuna, in seals and porpoises, in rain water in Scotland and Hawaii, in air-borne dust at Barbados, in deep-ocean fish, in caribou and polar bears, in penguins, and finally in snow on the Antarctic ice-cap.

DDT and DDE were not the only culprits; there soon were similar findings of other persistent chlorinated hydrocarbons, such as dieldrin, heptachlor, and its metabolite, heptachlor epoxide. In the late 1960s polychlorinated biphenyls (PCBs) were identified and quickly found to be major global contaminants. More recently attention has shifted to hexachlorobenzene, chlordane and its metabolites, mirex, and polychlorinated terphenyls. Environmental chemists are still studying unidentified peaks on gas chromatographic traces, and there are doubtless still more chemicals to be added to the list of global pollutants.

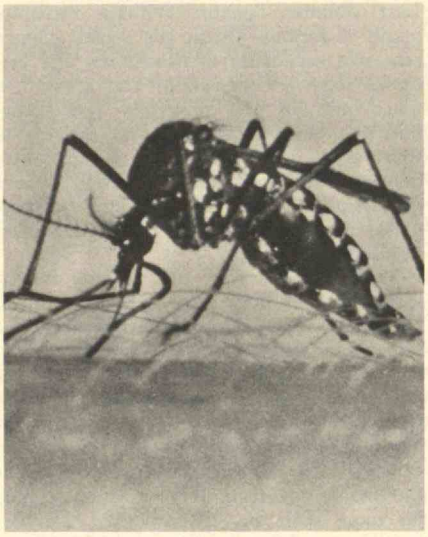
Most of these chemicals were first identified, not in water or air, but in tissues of predatory birds, mammals, or fish. A second environmental surprise was the extent to which these animals are able to accumulate and store residues of the persistent chlorinated hydrocarbons. The classic example is still that of Clear Lake, Calif.: In 1958 fish and fish-eating birds there were found to have acquired residues of DDD in their fat to levels as high as 1,600 parts per million (p.p.m.), after DDD had been applied to the water at a concentration of only 0.02 p.p.m. in 1957. Since then the same phenomenon of "bioaccumulation" has been observed for many other fat-soluble chemicals under both field and laboratory conditions. The highest levels of these chemicals are usually found in fish-eating birds and mammals; a record of sorts was set by an eagle found dead near Stockholm in 1966, whose fat contained no less than 3.6 per cent of DDE and 1.7 per cent of PCBs.

Mobilizing Non-volatile Chemicals

With hindsight, none of these phenomena should really have occasioned surprise. The debates about atomic fall-out of the early 1950s should have familiarized us with the phenomenon of bioaccumulation and with the ability of pollutants to travel around the globe in the air. What seemed inconceivable at first was that the inert chlorinated hydrocarbons could be similarly mobile. How could DDT or dieldrin, for example, with vapor pressures of only about 10^{-7} mm. of mercury, be mobilized into the atmosphere? How could substances with water solubilities of only a few parts per billion run off into streams and reach the open oceans? It seemed self-evident—at least to those who were not trained in physical chemistry—that the disappearance of these chemicals from foliage and soils over a period of a few years must represent degradation *in situ*.

These simple arguments have three flaws, however. Over periods of years, even substances with low vapor pressures can volatilize to a significant extent. PCBs, for example, were widely used as plasticizers in plastic resins and adhesives; measurements and calculations have suggested that volatilization losses might amount in typical cases to 10 per cent or more per year. Agricultural soils are porous and are repeatedly permeated with rain water, which then evaporates; this is an extremely efficient steam distillation system and has been shown to lead to rapid volatilization of certain pesticides. Most important of all, many of these chemicals have actually been disseminated in large quantities directly into the air. One significant route of loss of PCBs, for example, is thought to be by volatilization from scrap materials in burning dumps. Many pesticides have been sprayed onto crops or forests from the air, and it is now known that a large fraction of the sprayed material evaporates or disperses before reaching the ground. In one experiment in which a liquid formulation of dieldrin was sprayed onto a field from a boom at a height of only two feet, only 40 to 70 per cent of the sprayed material reached the surface of the ground, and much of this evaporated within a few hours unless it was immediately covered by turning over the soil.

As we have learned the importance of dissemination into the air, we have also found that water transport is relatively unimportant. Early reports of fish kills and damage to other aquatic organisms had suggested that run-off in water was an important route of release of pesticides. However, some of these incidents have been traced to direct applications to water or marshes (for mosquito control) and others to deliberate discharge into waterways. Disposal into drains and sewers has probably been a major route of release of PCBs (for example, in spent or leaking hydraulic fluids) and has been locally important for DDT and dieldrin (e.g., effluents from manufacturing or moth-proofing plants).



Mosquito eradication programs have sometimes had disastrous side effects: DDT applied directly to water or marshes has killed fish and damaged other aquatic organisms.

Apart from these direct discharges, however, it is now known that most chlorinated hydrocarbons are not very freely transferred from land into waterways, because they are strongly adsorbed to soil particles. The principal means of transfer into water appears to be by erosion of contaminated soil particles; this is most important for pesticides such as aldrin and heptachlor which are applied directly to tilled land subject to erosion.

In arable land not subject to special soil conservation practices, soil erosion losses are typically of the order of 60 tons/hectare annually. With a pesticide residue of

0.4 p.p.m. in the topsoil, this would represent a translocation of about 25 g./ha. of pesticide per year. While this may represent a very significant input of toxic material into local streams, it is only a very small fraction of the total amount applied—typically 1 kg./ha. for a soil pesticide; hence it is a very small element in the mass flow. It has been estimated, for example, that the Mississippi River carries only about 10 tons/yr. of chlorinated pesticides into the Gulf of Mexico, a minute fraction of the thousands of tons applied annually in its drainage basin and only a few times more than the amount that blows into the gulf on the Trade Winds from Africa and Europe.

The principal significance of the discharges into water, limited as they are, is that they lead locally to very high accumulations of pesticide and PCB residues wherever the sediments are deposited. Such "pollutant traps" include reservoirs in the American Midwest, the lower Great Lakes, the Baltic Sea, and various semi-enclosed marine basins such as the Gulf of St. Lawrence, San Francisco Bay, the Irish Sea, and the Japanese Inland Sea.

Another potential route of transport of these chemical residues—in the bodies of mobile animals—has been discussed in the past but is now thought to be quite negligible. Although individual animals accumulate some of the chemicals to high levels, their total mass is very small compared to that of the oceans or soils of the earth. Calculations for DDE and PCBs suggest that the total quantities stored in the biota are less—probably much less—than 1 per cent of the total amount circulating in the environment (much of the remainder is probably adsorbed onto soils and sediments). The only movements of animals with any significance at all for residue transport are the annual migrations of seabirds between the northern and southern hemispheres; these have been estimated to lead to a net transport of no more than two or three tons of these chemicals southwards each year.

Tentative Global Transport Models

Putting together these observations and calculations, it has been possible recently to formulate outline models for the transport of these persistent chlorinated hydrocarbons in the global environment.

Most of these chemicals are released directly into the air or are applied to agricultural systems, from which they volatilize at varying rates (which depend strongly on soil type, moisture, temperature, and management practices). Smaller amounts are released directly into waterways. The principal route of loss from land is by covolatilization with water; smaller amounts run off with eroding soil particles. Transport in the air is usually at low altitudes and often in association with particulates; the chemicals return to the land or sea in dry fall-out or in rain water. The four major sinks—of varying importance, depending on the properties of the chemicals—are biodegradation in soils and sediments, photochemical degradation in the atmosphere, sequestration in shallow-water sediments, and transfer to the deep oceans.

Some quantitative developments of these models have given reasonably plausible results, at least for the better-studied chemicals: DDT/DDE, aldrin/dieldrin, and the PCBs. Typical concentrations of these chemicals are of the order of 10^{-6} to 10^{-7} (weight/weight) in soil and particulates, 10^{-11} in surface waters and rain water, 10^{-11} to 10^{-12} in air, and 10^{-12} to 10^{-13} in sea water. These concentrations can be related to each other and to known rates of production and release of the parent chemicals in a way that is consistent with our knowledge of mechanisms of volatilization and particle transport. Variations from the typical concentrations can often be related to specific properties and uses of the chemicals. Although environmental concentrations are often near the margin of detectability, and although the critical measurements are very scanty, we do seem to understand now in very broad outline how these chemicals move through the biosphere.

Nevertheless, these models are still largely empirical. It is extremely difficult to apply them to a new chemical with slightly different properties and to predict its mobility. There are in fact a number of anomalies in our knowledge of individual chemicals which prevent us from extending the models to greater detail. In the next article I will discuss some of these anomalies and show that our inability to explain them reflects a serious lack of knowledge about fundamental biogeochemical processes.

Ian C. T. Nisbet, who writes regularly for the Review, *is Associate Director of the Scientific Staff of the Massachusetts Audubon Society.*

The Washington Energy Show

Washington Report
by
Victor Cohn

Energy has finally been reorganized. Or has it?

For a guide to the still-confusing Washington of the present, look back. For the past four years one of the most difficult questions to answer about energy has been: "Who's in charge?"

Who indeed? This remains part of the problem, for the constant changing and shifting of Washington's energy bureaucracy can be compared only to one of those French bedroom farces in which husbands, wives, lovers, and mistresses frantically race in and out of rooms through multiple doors, screaming imprecations but consummating nothing.

Consider the Washington energy show.

In November 1970, to pick an arbitrary starting point, federal energy decisions were made by 64 agencies. In that month Paul McCracken, then Chairman of the President's Council of Economic Advisers, released a study warning of future shortages. The warning was ignored.

In 1971 David Freeman, then energy adviser in the doomed White House Office of Science and Technology, talked of the need to be "prepared for the worst." That summer President Nixon did become the first chief executive to issue a statement on energy policy. He did nothing, however, about coordinating the often-conflicting policies of those 64 agencies.

The nominal assignment of coping with future shortages of fossil fuels still belonged to Brig. Gen. George Lincoln, the almost unknown head of an all-but-forgotten White House appendage called the Office of Emergency Preparedness (the anemic descendant of World War II's war mobilization machinery).

In January, 1973, General Lincoln retired, and presently O.E.P. was abolished.

In the winter of 1972-73 presidential assistant Peter Flanigan—who had served as an environmental overseer—was at least given the job of thinking about energy and preparing what was intended to be an important Presidential policy message on the topic.

In February, 1973, meanwhile, systems analyst Charles DiBona became the President's "special assistant on energy matters." DiBona had headed the Center for Naval Analyses, managed by the University of Rochester. He had no energy experience. He was given only a five-man staff.

He had to report to the President through a new energy committee consisting of then-Secretary of the Treasury George P. Shultz and presidential assistants John Ehrlichman and Henry Kissinger, men mainly preoccupied with other matters, including the world's and their Administration's survival. DiBona later said that he found only "apathy" about energy at the White House.

DiBona did recommend greatly expanded research and development. Roy Ash, Director of the Office of Management and Budget, who was no friend of Shultz, vetoed it.

In April, 1973, Mr. Nixon delivered his energy message, another Nixon "first." However, he rejected talk of any "crisis" and sounded no note of urgency. Indeed, he carried water on both shoulders by both warning against "a false sense of security" and saying, "We should not be misled by pessimistic predictions of an energy disaster."

John Ehrlichman, chief White House assistant for domestic affairs, now himself took overall charge of energy for a time. Then, at the end of June, 1973, the President made John A. Love, Governor of Colorado, Director of a new White House Energy Policy Office.

There was now to be a real presidential thrust, it was announced, to reorganize and sharpen the effort. But Love managed to see Mr. Nixon only three or four times during five months on the job. This was partly, of course, because the Presidential attention was focused on Watergate and survival. But also there was no national mood yet for an energy effort.

Came the Yom Kippur War and the six-month Arab oil embargo, triggered by U.S. support for Israel. The embargo cost this country—by one recent calculation—a $10-to-$20-billion drop in gross national product and some 500,000 jobs. Now there was energy crisis aplenty, but John Love never managed to take charge. Ash and his O.M.B. feuded with Shultz and his increasingly influential deputy secretary, William Simon, at Treasury.

In November, 1973 Gen. Alexander Haig, Jr., who had become the President's Chief of Staff after the ignominious Haldeman-Ehrlichman departure, almost desperately ordered O.M.B. to assemble a task force of 80 specialists from various agencies to prepare some realistic options and strategies. This group was headed by John C. Sawhill, then O.M.B.'s Associate Director for Natural Resources, Energy, and Science. Sawhill quickly won good marks for his energetic, take-over style.

Another body had gone to work in June, a task force headed by Dixie Lee Ray, head of the Atomic Energy Commission, ordered to deliver up by December a plan for energy research and development. This gave Mr. Nixon a blueprint which he chose—quite unrealistically—to use in December, 1973, for his "Project Independence" to give the United States energy self-sufficiency by 1980.

In late 1973 Nixon also replaced the ineffectual Love as energy boss with the effectual Simon. Shultz later departed, Simon became Secretary of the Treasury, and John Sawhill was made first administrator of a new Federal Energy Administration established by an impatient Congress.

The Politics of Energy

The upshot of all this shuffling and reshuffling? More reshuffling.

Sawhill pressed hard for a tax on gasoline and for other truly tough oil conservation measures. Asked by Senator Henry Jackson whether the nation had a clear policy yet to get oil prices down, he replied: "At present the United States does not have a policy . . ." In late October Sawhill was fired.

President Gerald Ford had already announced that Secretary of the Interior Rogers C. B. Morton would head a new Energy Resources Council and become his "overall boss" of energy programs. Morton quickly began snatching away F.E.A. powers—for example, assigning Transportation Secretary Claude Brinegar to keep tabs on somehow making automakers "voluntarily" improve fuel economy by 40 per cent by 1979; and assigning Commerce Secretary Frederick Dent to encourage all industry to use less energy to manufacture steel, aluminum, and other products.

At this writing a good deal of confusion again reigns after the short periods of clearer leadership under Simons and Sawhill. There are reports of damaged morale within an F.E.A. unsure of its future role and importance.

Congress in October passed an Energy Reorganization Act which established both the Energy Resources Council (which it envisioned as a mere coordinating body) and the new Energy Research and Development Agency—the converted Atomic Energy Commission (with A.E.C.'s regula-

Continued on p. 68

Science in Our Seamless Web

Special Report
by
Lawrence M. Gould

I dislike hearing people talk about *the* scientific method. Science is simply the art of understanding nature, including man, of course, using *all* rational methods. There are a thousand scientific methods, and their only common thread is that they are all rational.

Science's greatest gift is critical analysis. It permeates all segments of our lives. Our civilization is based on it. But it is possible to pursue even the noblest ideas beyond their proper limits and I think we may have done that with critical analysis. Not everything lends itself to library research or laboratory analysis. The analysis of a problem is not the same as its solution. The parts, even if they are complete, are not the same as a whole, and sometimes analysis deludes us into thinking that we know all about things whose inner reality we miss. For me there is a double road to truth—the road of analysis, or science, and the road of intuition. The first road, which has been my road, takes man only part of the way. I think we must know that Hamlet is one of the seven wonders of the world, Beethoven a musical genius, and the Parthenon a great building. No amount of argument or critical analysis will prove these things. But they are important to me, and I cannot distinguish between them and my experience as a scientist.

Science as we understand it began with Francis Bacon about three centuries ago. At one time he said, "The sure and lawful goal of the sciences is none other than this: that human life be endowed with new discoveries and power."

Over the years a gradual change has come about. In Bacon's time the important thing was to learn how to do things because so few things could be done. But today the problem is what *should* be done amongst all the things that *can* be done. This involves value judgments by the scientific community; and this in turn makes it important to say that the choice of extrinsic goals cannot be determined purely by the methodology of science. There is no straight path from fact to value, and if we rely on science alone, questions of purpose will not be answered.

Resources of Science and Values

So it is that, however one wants to say it, ours is a period of disenchantment—disenchantment with the realization that prosperity and comfort do not assure health and happiness, that material progress often has consequences that spoil the quality of life. We hear much about the revolution which is sweeping across the country amongst us. And it is true: The paradox of our revolutionary condition is the existence of despair, disaffection, and contempt within a society that is prosperous, progressive, and democratic.

If the 1970s are the beginning of a new civilization, then it will not be because we have walked on the moon or plumbed the depths of the sea, but because we have learned that wealth and power and even knowledge are not necessarily good in themselves but may become instruments of good or evil.

It is not the nature of either science or technology to make men happy—only to make them more effective. I know of no discovery of science that does not have a dual aspect; there is no way of classifying knowledge as safe or unsafe. All knowledge is dangerous because knowledge is power, and every capacity is a capacity for evil as well as good. Science and technology have not increased man's folly; I think they have simply made him more dangerous.

We are now faced with the challenge of adapting mankind to the new scientific and technological habitat he himself has built. We have created an environment from which we cannot escape. We do not have the option of a return to the primitive nor of a world without science or technology.

I do not accept the mystique that science and technology have laws of their own, over and beyond the human. Our culture is a seamless web.

I know of no way that we can keep *homo sapiens* from wanting to know why and from putting the knowledge which emerges from his curiosity to work. Science came into being because man is curious and relatively intelligent, and so he is driven to use his senses in discovery to better understand his world. Human rationality is the most important realm in which man can fruitfully live. Education and research, I think, are man's greatest allies in his quest for fulfillment, and apathy and ignorance are the most dangerous enemies. The temptation to lash out at science is understandable and perhaps satisfying; but it is a far more dangerous threat to our survival than technology itself. For if we exhaust our intellectual resources or let them wither and die, we shall not have the tools that we shall need to save ourselves.

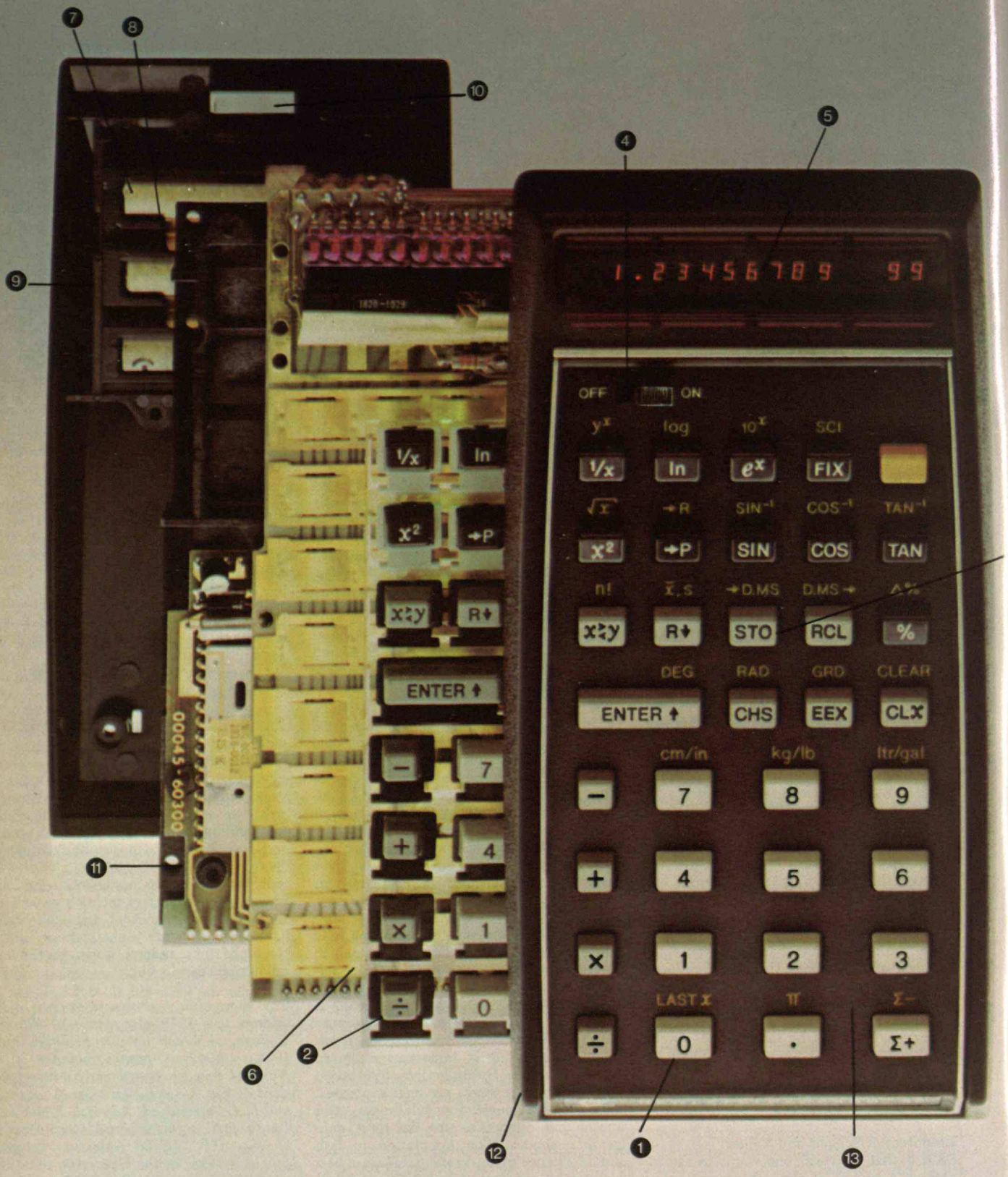
There is no way for mankind to retreat from reason or science now. Rene Dubois has said, "The viability of our civilization clearly depends on a reorientation of science and technology, but such a necessity should cause no alarm about the future." These are brave words from one of our greatest scholars, and I believe that it is only with technology that we can climb out of the pit into which we have dug ourselves. There is no future for mankind which does not depend upon the expansion of scientific knowledge and of its technological application.

As a geologist, I know from the rocks and the fossils in them that the history of life extending back two billion years on this planet has been largely a history of failures. Millions of species have been rendered extinct in the evolutionary process. Man is distinct from all of them; he is the only one to know in advance what is going to destroy him. This is a very important and hopeful sign; in it lies a possibility for our own salvation.

I have not said that only science and technology can save our world. I have said that our world cannot be saved without them. The ultimate question that will decide whether we survive is not to be found in science and technology. It is this question: "Can we restrain our fears and our hate until we can create an adequate organization of society that will utilize the new tools of science and technology for peace and security?" That is the ultimate question. To the extent that we can understand the new powers of science and technology and use them for the benefit of mankind everywhere, we have the right to hope, indeed the right to a radiant hope, that a new renaissance can be ours.

This short essay is drawn from Dr. Gould's address to a 1972 convocation at Carleton College, of which he was President from 1945 to 1962. A former member of the National Science Board and former president of the A.A.A.S., Dr. Gould was Second-in-Command of Admiral Richard E. Byrd's first Antarctic expedition, Director of the U.S. I.G.Y. Antarctic Program, taught geology at the University of Michigan and Carleton College before becoming its President, and is now a member of the Geosciences Department of the University of Arizona.

Take an unhurried look



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Energy to the Rescue of Aerospace?

Science-at-Large
by
Peter Gwynne

Hewing tightly to the principle that every cloud has its silver lining, it seems that the energy crisis is just about the best thing that could have happened to the U.S. aerospace industry. The tasks of using what energy is now available with maximum efficiency and of ensuring balanced development of a variety of new energy resources over the long term are tailor-made for the precise approach that has, at least in general, marked the industry's attack on many aerospace projects.

What's more, the crisis comes at a time when the industry is set to go into a period of prolonged hibernation. On earth, the big jet planes have been largely developed, and the production of a U.S. supersonic transport seems as far away as ever. In space, the situation is just as bleak. With Apollo just a memory and Skylab already completed, the only U.S. manned flight in prospect over the next half-decade is this year's joint Apollo-Soyuz flight with the Russians.

Of course, the much-vaunted space shuttle, designed greatly to reduce the cost per pound of lifting payloads into earth orbit, is looming ever larger, but it certainly does not have the political attraction and the same fast financial investment of Apollo a decade ago. So tightly is NASA's budget constrained—at little over $3 billion per year, by contrast with almost double that in the agency's Apollo heyday—that the initial launch of the shuttle had to be postponed six months, to mid-1979, in order to prevent the sacrifice of a number of unmanned planetary probes.

Certainly, preliminary shuttle work and continuation of the nation's planetary investigations will keep the wolf from the door of the industry's sophisticated space complexes, but the workload hardly approaches that of Apollo days. Thus the arrival of the energy crisis—and the effort to solve it—comes at just the right time to take up the slack.

Rising to the Challenge

A number of companies are already rising to the challenge. Grumman Aerospace, builders of the lunar module, for example, has set up an energy consultation service that deals with the problems of providing power for factories, offices, and other buildings. The Grumman experts first look at the methods available for reducing energy usage, without any introduction of new technology—such simple processes as ensuring that all the lights in particular sectors of a building are turned off and improving maintenance of equipment. This approach alone, according to the Grumman engineers, can reduce fuel usage by up to 20 per cent.

With an eye on the future, the company is looking at the possibility of using energy resources at present unexploited. Using its aerospace expertise, for example, Grumman has designed a satellite that could support orbiting solar collectors. Recently, the company has also signed an exclusive agreement with Princeton University to use a unique type of wind generator, known as the Sailwing, designed by Princeton aeronautical engineer Thomas Sweeney.

Grumman is far from alone among the aerospace companies in getting into the expanded energy business. R.C.A. plans to erect a solar-heated addition to its headquarters in New York's Rockefeller Center; General Electric has built an experimental solar heating system for a junior high school in Boston; Hamilton Standard is hastening research in such space-related areas as fuel cells; and a number of companies are studying the new, but relatively obvious, technique for feeding waste heat from computer rooms back into the heating system of the buildings housing the rooms.

N.A.S.A. itself is also moving into the energy vacuum. Engineers at the Marshall/Space Flight Center in Huntsville, Alabama, where the Saturn rockets were brainstormed, have built three interlinked house trailers heated and air conditioned experimentally by the sun; N.A.S.A.'s Lewis Research Center in Cleveland is soon to erect a generator in Sandusky, Ohio, to test the potential of wind power in production of commercial electric power; and the same center is also developing an experimental solar collector system to heat and cool a single story office building that will be erected at the Langley Research Center in Hampton, Virginia.

Energy Is the Simpler Task

Plainly, the space industry is more than a little involved in providing the nation with energy in forthcoming years. But will it be successful in its new task? After all, the present state of affairs is not too dissimilar to that at the end of the sixties, when the aerospace companies, desperate to replace their Apollo work with civilian endeavors, were hailed as the potential saviors of the environment. This particular application of the space program's technical expertise never even got off the ground. It turned out that the aerospace engineers virtually had to go back to school before they could even understand the environmental problems.

Is the energy situation different? The trouble with the aerospace-environment merger was the lack of any specific understanding of the magnitude of the task ahead, to say nothing of the absence of any specific goal. Telling aerospace companies to clean up the environment in the absence of any reliable measure of how dirty it was in the first place or any idea of the political priorities was simply too tall an order for them.

In contrast, developing the methods necessary to husband our power and keep up with forecast demand for energy in the future is a simpler task—and one for which the industry is well equipped. In space, the major concern is to cut the corners in such a way that the weight of payloads is reduced to a minimum, and to make the energy sources as efficient as possible. When it comes to energy shortages on earth, the same philosophy is applied—in somewhat scaled-up form.

One immediate advantage of the interest of the space industry in energy problems is the near-guarantee that the companies will take a catholic approach to energy resources. The present predicament was brought about by excessive reliance on one commodity—oil. It will be overcome only by creating a range of energy sources. Thus we must hope that no sudden panacea emerges on the scene to encourage once again the attitude that brought about the present trouble. This time, in other words, it will be better if the tortoise of the engineering method beats the hare of scientific inspiration.

Formerly Managing Editor of Technology Review, *Peter Gwynne is now Science Editor of* Newsweek.

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

A Search Resolved: New Goals, Old Tenets

What were the responsibilities of an educational institution such as M.I.T. during the past decade while the nation, in a mood of "uncertainty and deep searching," devoted much of its thought to "taking stock of the complexities and incongruities of the contemporary world"?

They were two-fold, write President Jerome B. Wiesner and Chancellor Paul E. Gray in their annual report to the M.I.T. Corporation for 1973-74:

—"To identify the continuing value of engineering and technology in our society."

—"To maintain a major visible commitment to fundamental research, the creation of knowledge for its own sake.

"The challenge was to continue and intensify our efforts in the face of widespread skepticism and even antagonism, to relate our efforts to the problems of society and industry created by the forward sweep of technology, and to address people's growing concerns about whether the resulting world truly serves them well," they write.

It was a hard era for institutions and people devoted to progress through scientific knowledge. "We faced a society uncertain, . . . seriously questioning the role of technology, a political mood less understanding and supportive of basic research than before, and a government policy designed to cut back graduate education in science and engineering."

But their "major perception" of the past year at the Institute, write President Wiesner and Chancellor Gray, is of "a quickening of pace—a focusing of energies, consolidation of efforts, and progress toward the achievement of reaffiirmed long-term goals." They are confident, they write, that "education, science, technology, and art, broadly conceived and used in the service of a free, democratic society, remain basic ingredients of genuine human progress and happiness.

"We see ahead a new era of understanding and caring in the relationships among people, their environment, and their society—an era in which technology is responsive to social and environmental needs as well as to individual material needs."

The "Increasingly Collegial Role" of Students

President Weisner and Chancellor Gray devote much of their report to the 15-year evolution of M.I.T.'s undergraduate education in response to three major influences:

—The "significantly improved" and more diversified high school experiences with which students enter the Institute.

—The broad interests expressed by many undergraduates, and their unwillingness "to make an early exclusive commitment to a single career path."

—The increased concern among students and faculty alike with understanding and resolving problems generated by technology itself.

Hence a series of developments in undergraduate education which change (but do not weaken) M.I.T.'s commitment to its founder's principle of maintaining "the highest intellectual quality while seeking useful knowledge":

—Greater flexibility and incentives in undergraduate programs for students to respond to their interests in fulfilling even the core requirements of the first two years.

—Far greater flexibility for upperclass undergraduates to follow—or even to create —programs which respond to their special desires.

—Early introduction to problem-oriented, professional experiences for all undergraduates.

—More varied opportunities for students who want to study in other institutions—including foreign universities.

—The development of "new and more varied ways in which students become engaged with social and humane issues."

—An "increasingly collegial role that students have come to play in the educational and research life of the Institute." This is "a wholly beneficial development . . . that holds potentials we are only beginning to explore," write President Wiesner and Chancellor Gray. Though there are plenty of unsolved problems (for example, how to develop in M.I.T. students "a deep commitment to nonquantitative ways of thinking, and to an understanding of humanity") its principal officers conclude that M.I.T. emerges from its "years of searching" with "a sense of optimism" based on these developments and on "the spirit and quality" of the young people who become its students and then its alumni.

(Continued on page 69)

An evolutionary addition of new technology focusing on automation has been chosen to control the airways for the larger fleets of the 1980s and 1990s

Testing a collision avoidance system: Two Piper Cherokees flying for M.I.T.'s Lincoln Laboratory test the Discrete Address Beacon System/Intermittent Positive Control Collision Avoidance System over another M.I.T. facility, the Haystack Radio Observatory, Westford, Mass. The pilots use the Haystack radome as a visual landmark.

David R. Israel
Federal Aviation Administration

Air Traffic Control: Upgrading the Third Generation

The nation's air traffic control system is the responsibility of the Federal Aviation Administration (F.A.A.) of the Department of Transportation. It consists of an extensive network of navigation, surveillance, communication, and control facilities collectively referred to as the National Airspace System (NAS). Originally intended for use during poor weather or under conditions requiring the use of Instrument Flight Rules (IFR), the "system," with its control features, is now mandatory for all high-altitude flights in the so-called positive controlled airspace and at major terminal areas. At intermediate and low altitudes, the system exists along defined airways. Visual Flight Rule (VFR) operations—subject to Federal Air Regulations concerning air-space use, but not under active control of the system—are permitted outside these airways in this "mixed airspace."

All of the nation's 2,600 air carrier aircraft utilize the system, and they are at present its major user. Most fixed-wing aircraft in the military fleet—numbering some 20,000 aircraft—fly in the system, except for training and other specialized operations. Participation in the air traffic control system varies widely among the general aviation fleet—a total of some 150,000 widely varied aircraft types utilized in many types of aviation activity including air taxi operations, executive service, flight training, recreational flights, agricultural activity, and so on.

Four primary functions of control, navigation, surveillance and communication are interrelated in today's air traffic control system. Aircraft flying in the system must be equipped with basic electronic instruments (avionics) and are required under Instrument Flight Rules to file a flight plan with an air traffic control facility. If "cleared" along the flight plan route, the pilot is expected to navigate himself by reference to ground-based navigational aids. The actual progress of his aircraft is monitored by a network of ground-based primary and secondary surveillance radars. The former utilize basic radar echos; the latter use a ground interrogator to elicit coded responses from beacon transponders in the aircraft (Air Traffic Control Radar Beacon System or ATCRBS). There is no ground determination of altitude; this is reported by the pilot over voice radio or transmitted automatically to the ground in an altitude-coded transponder response. Revisions of the flight plan may be requested during a flight; new clearances, based on the aircraft's progress, weather conditions or the presence of other traffic, are communicated by controllers to the pilot. The control functions are divided between enroute Air Route Traffic Control Centers (ARTCCS) and terminal towers or Terminal Radar Control (TRACON) facilities.

The operation of the system can be characterized as "dynamic" and in real time. As a flight progresses, the controllers in the ground system continuously monitor the current position and check some limited time or distance ahead to ensure there are no violations of prescribed separation standards with other aircraft. The effectiveness of these checks is limited by the fact that other traffic may be joining the system, by the effects of winds, and by the possible need for route or altitude changes due to weather. For these reasons, it is not feasible to grant an aircraft a long-term or complete reservation of conflict-free airspace along a route.

This system had very modest beginnings in the 1930s as an air navigation network. Its growth has been characterized by several major discernible phases or "generations." From the "first generation," which was a completely manual system based on time-separations established through a process of flight progress strip postings, the system proceeded to extensive use of ground-based surveillance from primary radar and then through development of the ATCRBS. This was the "second generation," which also saw the introduction of computers to accomplish the printing of flight progress strips in en-route centers. The "third generation" system, characterized by the further use of computers in en-route and terminal facilities, is now largely implemented. The semi-automated en-route system now being deployed is known as National Airspace System Stage A; the improvement to the terminal-area system is known as the Automated Radar Terminal System, or ARTS III.

The present functions of the ARTS III system are primarily related to the reception and decoding of identity and altitude-encoded beacon information, the tracking of beacon-equipped aircraft, and a presentation of track data with letters and numbers to identify each aircraft in conjunction with the radar and beacon information in a plan-position display. Some 61 ARTS III systems are now operational at major terminals.

The NAS Stage A system now being installed at 20 en-route centers is considerably more complex. It provides for seven functions:—On-line entry of proposed flight plans from both local and remote sources.—Automatic error and legality checking of all filed flight plans

and other inputs.—Automatic flight plan update or revision prior to the issuance of the clearance.—Manual initiation of automatic processing on departing flights.—Automatic tracking of both beacon-equipped and non-beacon aircraft (radar tracking).—Automatic flight plan updating, data forwarding, and display.—Automatic track and track-control updating, data forwarding, and display.

Customers, Objectives, and Constraints

From an engineering and development point of view, customers of an improved air traffic control system consist of two major groups. First, there are the *operators* of the system. Using the term rather broadly, it includes the 25,000 air traffic control specialists' manning centers, towers, and flight service stations and the 10,000 F.A.A. personnel associated with the installation and maintenance of the equipment and facilities. The second customer category is composed of the *users* of the system. These users—air carrier, military, and general aviation—are not a homogeneous group; there are well-known differences in their intended use of the airspace and in their ability to purchase and use various avionics. These widely varying viewpoints, interests, and capabilities which must be considered are a key point in the planning and development of the air traffic control system.

At the present time, the management and operation of the air traffic control system—including substantial amounts for new facilities, grants for airport development, and establishment and enforcement of aircraft and flight standards—requires a yearly expenditure of just under $2 billion and involves some 50,000 F.A.A. employees. The trend has been for the size and cost of the F.A.A. to increase in almost direct proportion to the amount of air traffic activity.

The air traffic control system is under continuous development, motivated by three general goals: to increase and improve performance, to improve safety, and to reduce costs.

Higher capacities, fewer and shorter delays, and improved service—including greater reliability and continuity—are obvious objectives for improved performance. It is also desirable to increase the geographical coverage of the system.

From the point of view of capacity, the situation varies geographically. Through use of radar, with its accurate and essentially continuous surveillance, separation standards over the continental U.S. have been reduced to a few miles. Broadly speaking the en-route system currently has no pressing capacity problems except at its interfaces with major terminal areas and in special situations where large volumes of airspace are temporarily denied due to bad weather conditions.

The major system capacity problems are in the terminal areas, where all flight paths converge, and on the surface of the airport itself, where the number of available runways and their occupancy times are limiting factors. Each terminal area has standard approach and departure routes which can be flown by reference to navigation aids. However, efficient handling of a large number of aircraft with differing performance characteristics requires extensive "vectoring" by ground controllers, who must meter and space aircraft to achieve maximum take-off and landing rates.

Thus air traffic control is more than just keeping aircraft apart; the more difficult problem is to bring them together safely with relatively small separations at the major airports. This problem of managing, organizing, and sequencing air traffic becomes a prime consideration in the review of proposals for new or improved air traffic control systems.

Three principal concerns arise in maintaining or improving safety: elimination of air-air collisions, landing or take-off accidents, and accidents during ground operations. It is interesting to note that only a small percentage of U.S. aviation fatalities (under 5 per cent) are associated with mid-air collisions.

The third objective is to prevent escalation of system manpower and operating costs as the number of controlled aircraft and the quality of control and safeguards increases. To achieve this will require increased controller productivity, which in turn will be possible only with greater automation in the air traffic control system. But the expense which falls upon the owner and operator of the aircraft must also be minimized, and this goal is not always consistent with improved service and greater automation.

These objectives have to be considered against a backdrop of constraints and requirements which cannot be ignored. Two of these are the protection of the environment, including minimization of air pollution and noise, and the conservation of energy. The third is to provide the greatest possible freedom of flight and access to the airspace for all users. National policy has been to foster and encourage general aviation activity, and the likely future growth of general aviation traffic strongly affects planning for future air traffic systems.

The objectives of air traffic control systems—high capacity, safety, and low cost—are given different priorities by different users; and one is often achievable only at the expense of another. The problem, says the author: "To design and engineer a system which represents an acceptable compromise." (Photo: William G. Osmun, Air Transport Association)

While it is not unreasonable to demand that a commercial airliner priced at $10 to $20 million carry several hundred thousand dollars of air-traffic-control-related avionics, such a requirement would be an intolerable burden to general aviation aircraft. Thus the need to accommodate airspace users who cannot make large investments in avionics or undertake their maintenance is a major constraint to planning for future air traffic control systems.

A fourth consideration—the concept of a "user charge" by which users of the airspace are expected to pay their fair share of the costs of the air traffic control services rendered—could seriously affect these matters. Taxes on aviation fuel and passenger tickets are used today to fund new airport and airway development, but there is no attempt to equitably recover all or part of air traffic control system operation and maintenance costs from the different users. As a requirement of the Airport and Airway Development and Revenue Act of 1970, the Department of Transportation must shortly submit recommendations for revised user charges to Congress. The form or impact of these recommendations is not yet known; however, various factors indicate that they may not have a major impact on general aviation, and planning must continue to anticipate the growing needs of the general aviation community.

The basic objectives of performance, safety, and cost are not mutually exclusive. Fully satisfying any one of them generally will not satisfy—and indeed may be accomplished at the expense of—the others. For example, to obtain more performance at less cost is exceedingly difficult. Furthermore, the needs and desires of various users of the airspace are not identical—nor even entirely compatible. Air carriers prefer positive control; general aviation largely prefers a minimum of control. The problem, then, is this: to design and engineer a system which represents an acceptable compromise among the varying requirements, constraints, and diverse needs and desires of the customers.

Future Requirements:
"A Rather Frightening Prospect"

What is the likely pattern of future air traffic? Data of recent years reveal growing public use of commercial aircraft and increasing private and corporate ownership of aircraft for business or pleasure. Commercial air passenger enplanements have recently grown at eight to nine per cent per year and some 10,000 new general-aviation aircraft have been produced each year. The corresponding expectation is that all measures of air activity, including both en-route and terminal-area traffic, will show continued substantial growth in the range of five to seven per cent per year; this means that the demand for air traffic control services will double every 10 to 15 years.

This is, frankly, a rather frightening prospect, for we can be certain that over the same general time period there will *not* be a doubling of major hub airports or the runways on these airports (in fact, little physical growth is expected with which to accommodate the increased demand), there will *not* be a doubling in the range of altitudes which aircraft desire to use, there will *not* be a doubling of major city pairs between which the bulk of this traffic will travel, and the radio spectrum available for air traffic control use will *not* double.

In air traffic control, 10 to 15 years is just about the length of one generation or, perhaps more pertinently, just over one air traffic control development/installation cycle. That is to say, the time period required for major equipment or subsystem efforts, measured from existence of a technology or technical possibility through the stages of concept, breadboard, test, prototype, decision, procurement, installation, and checkout to a point of widespread field operation, can be from 7 to 10 years—or perhaps longer if budgets are tight or international considerations are involved. Thus the expected doubling is in fact not very far into the future when measured in terms of system acquisition cycles.

In 1969 the Department of Transportation appointed an Air Traffic Control Advisory Committee to study this issue; its report contained the concept for an improved air traffic control system which could be achieved for the 1980s and 1990s, and this concept has essentially been adopted by the F.A.A. This is not yet a commitment to implementation; rather, it is a commitment to those engineering and development activities necessary to investigate and evaluate such a future system.

Alternatives: The "Clean Sheet" Approach

The Air Traffic Control Advisory Committee recommended evolution and improvement of the present ground-based and beacon-based system, with priority given to the greater use of automation and the introduction of a new concept of Intermittent Positive Control (IPC) *(see page 22)*. The Committee's recommendation is now referred to as the "Upgraded Third-Generation System" (UG3RD), building on NAS Stage A and ARTS III, which constitute the "third generation" system.

This UG3RD system has been weighed against a "fourth generation" system, the Advanced Air Traffic Management System (AATMS), put forth in an independent Department of Transportation study which began as a "clean sheet" approach; that is to say, it attempted to answer the question: What would you do if you could start all over? AATMS was based on a constellation of satellites for surveillance, navigation, and communication functions. The advantages of this satellite concept include complete coverage of the airspace in a single coordinate system, capability for independent altitude measurement, and the possibility of consolidated ground control facilities. The disadvantages include high reliance on single elements and hence high susceptibility to their failure, vulnerability to jamming—either intentional or not—and large initial investments for both ground and airborne equipment.

"Return Air Traffic Control to the Cockpit?"

A second challenge to UG3RD came from an Aviation Advisory Committee commissioned by Congress, whose report raised the question of "distributed management"—that is, a return of air traffic control to the cockpit. Described in this fashion, the idea seems attractive, but it has never been subjected to a detailed analysis or reduced from a broad concept to a specific design. Present thinking is that this idea is more properly described as "distributed responsibility," and it is not clear that one should build air traffic control systems around a system in which responsibility is distributed rather than focused. Plans for returning air traffic control to the cockpit also present difficulties of achieving efficient traffic organization and management. In a distributed system, each aircraft cannot determine what it should do without reference to the intentions and location of many other aircraft, and to provide each aircraft with such a current data base is difficult and expensive. Airborne collection of this data is not feasible; the data would have to be collected on the ground and relayed to the using aircraft. Overall system coordination and management and the need to guard against pilot blunders or equipment malfunction probably would require parallel operation of today's ground system—although perhaps more in a monitoring than a control mode.

In sum, the transfer of air traffic control to the cockpit is not a foreseeable development, since it is unlikely to increase capacity or decrease the traffic or data processing load on the ground system in any significant manner.

Airborne capabilities could, however, provide some "coast" capability in the event of ground system failure. And there is also the possibility that certain navigation functions in terminal areas and the responsibility for station-keeping between flights along a route can be assigned to pilots in properly equipped aircraft. One possibility is the so-called Airborne Traffic Situation Display (see page 25), in which a ground-derived picture is transmitted to aircraft by data link to help the pilot in terminal-area navigation and in flying closely-spaced parallel approaches. This concept is being studied by means of cockpit simulation tests at M.I.T.'s Electronic Systems Laboratory. One can also look forward to greater use of sophisticated airborne systems to help pilots adhere to flight paths furnished by a ground-based traffic management system. But the cost of the avionics for such systems probably precludes their use in all but a few air carrier or equivalent aircraft.

The conclusion of this major technology assessment effort was that systems using satellites or more distributed systems involving greater avionics capabilities do not seem to hold major promise over the next 20 years. The UG3RD and extensions to it can handle air traffic control requirements to the end of the century; in the meantime, experiments on satellite-based control and increased avionics capabilities will continue.

Nine Features of the Upgraded "Third Generation" System

Since the decision to proceed on its engineering and development, the Upgraded Third Generation System has been transformed into a broad system design which is highlighted by (but not restricted to) nine key features. Hardware and software development programs associated with these features have been initiated, with most test and evaluation activity scheduled for the 1976-1977 period. At that time, final system design choices and implementation decisions will be made, leading to initial operational capabilities in the early 1980s.

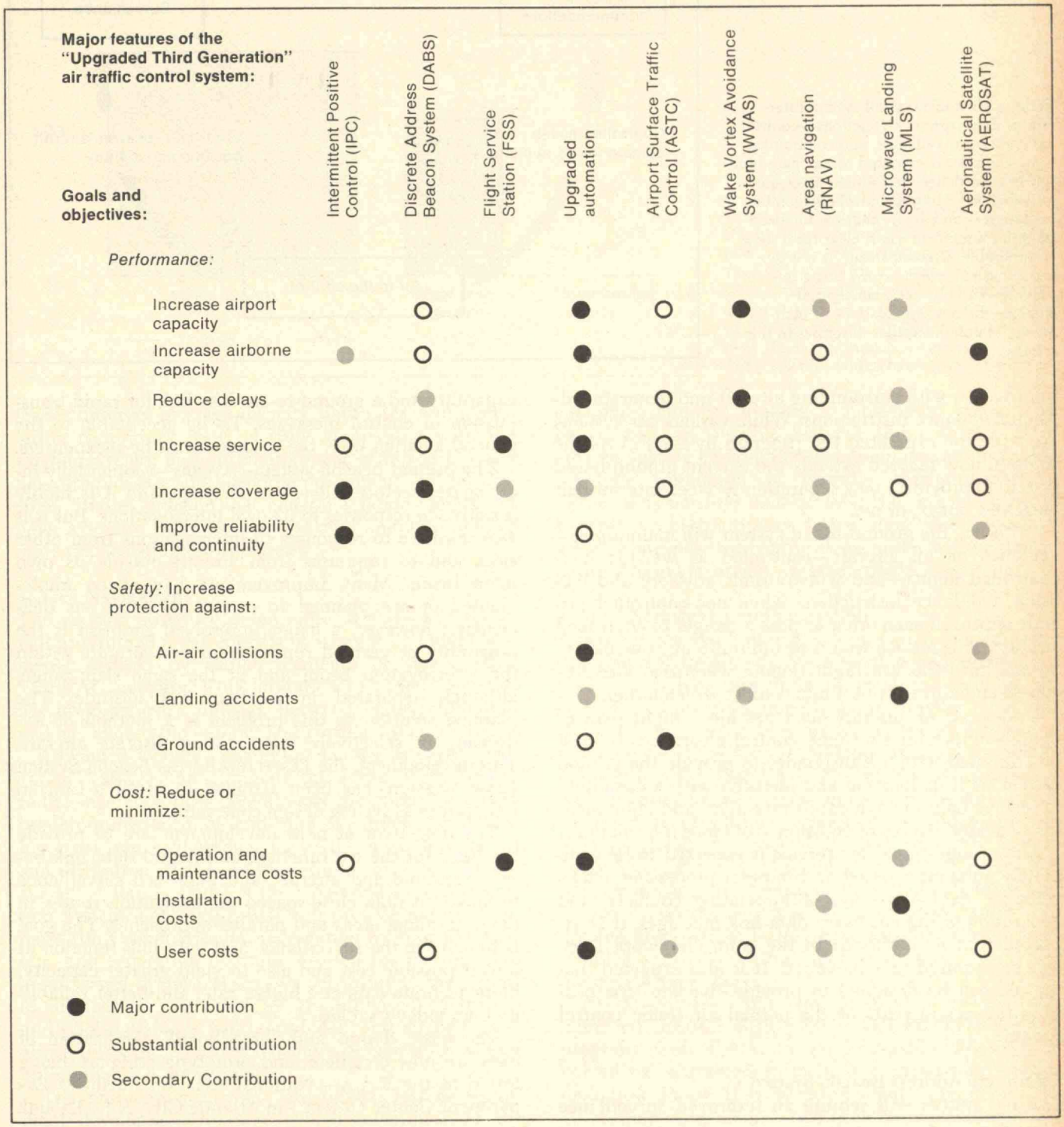
The nine key features are summarized below.

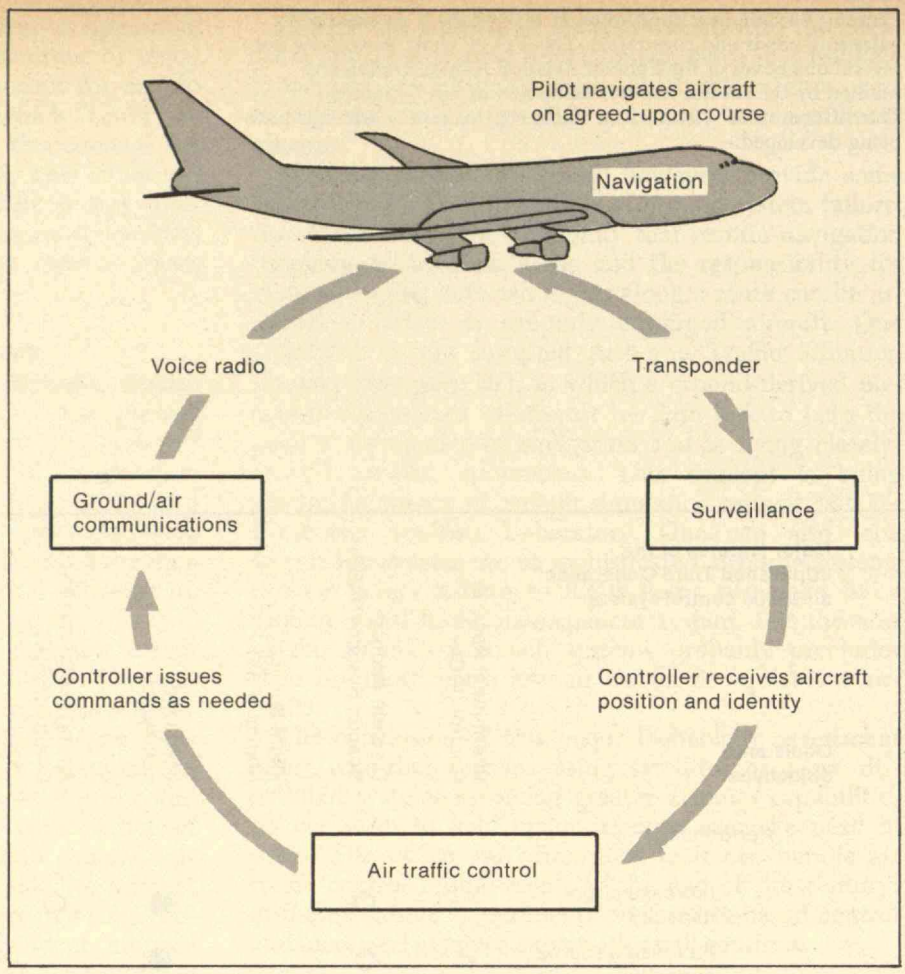
1. Intermittent Positive Control

As the volume of air traffic grows in the future, the probability of collisions among non-controlled aircraft or between controlled and non-controlled aircraft operating in mixed airspace is expected to rise, unless other measures are taken, at a rate somewhere between the first and second power of growth in air traffic activity.

One solution is to extend the limits of controlled airspace to include most general aviation flights, which form the bulk of the non-controlled flights. This places a heavy penalty on these aircraft (which, in terms of various measures of activity, will pass air carrier traffic by the mid-1980s), in terms of both freedom of flight and avionics requirements. Another solution, which places a heavy avionic burden on all aircraft, is to institute a mandatory airborne collision avoidance system (CAS) by which aircraft automatically exchange

Planning for any new application of technology is an exercise in balancing needs and constraints. This F.A.A. chart shows how the several objectives of the Federal Aviation Administration are fulfilled by the several features embodied in the "Upgraded Third-Generation" (UG3RD) air traffic control system which is now being developed.





Today's air traffic control system interrelates four primary functions—control, navigation, surveillance, and communication. The pilot is expected to navigate himself in accordance with a plan filed prior to departure; ground controllers monitor his progress and assure that the airspace the pilot intends to use is clear from some considerable distance ahead. It is a dynamic system which is now being improved—without basic conceptual change—by new applications of technology which the author describes in this article.

information with surrounding aircraft and generate collision avoidance instructions. While various CAS systems are under an expedited test program by the F.A.A., the solution now favored extends the current ground-based system to provide a new separation service: Intermittent Positive Control, or IPC.

With IPC, the ground-based system will maintain surveillance on all aircraft—controlled as well as non-controlled flights—and will transmit advisory and collision avoidance instructions when non-controlled aircraft approach each other or pose a danger to controlled aircraft. This service would be intermittent; it would intervene into the VFR flight regime when one aircraft's course and altitude put it into conflict with another.

Under IPC, an aircraft need not file a flight plan or operate under an air traffic control clearance. It must be equipped with a transponder to provide the ground system with its location and identity, with a capability to receive collision avoidance messages, and equipment for a cockpit display of collision avoidance information.

The ground-based IPC service is expected to be completely automatic, based on computer processing of surveillance data, detection of impending conflicts, and generation of the necessary data link messages; it is expected that *no* additions to the controller work force will be required to achieve IPC. It is also expected that the IPC can be designed to provide "backup" for possible failures in parts of the normal air traffic control system.

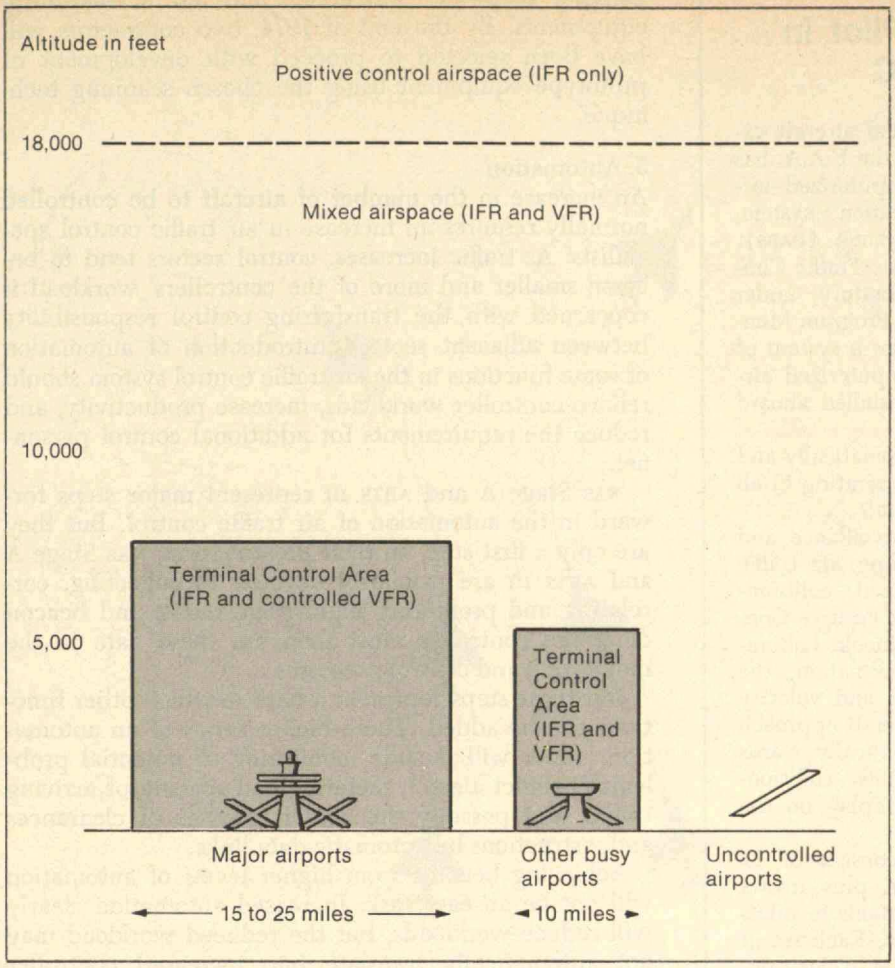
2. Discrete Address Beacon System

The IPC system will require an improved surveillance capability and a ground-to-air data link for rapid transmission of control messages. To be acceptable to the general aviation user, the avionics must be inexpensive.

The present beacon system—ATCRBS—sequentially interrogates sectors (slices) of airspace, and it is highly sensitive to responses to its own interrogations. But it is also sensitive to responses to interrogations from other sites, and to responses from aircraft outside its own main beam. Many improvements have been implemented or are planned to correct these ATCRBS deficiencies; however, a major unresolved problem is the possibility of garbled replies from two aircraft within the interrogation beam and at the same slant-range, although separated in location and altitude. The planned solution to this problem is a method of addressing or selectively interrogating discrete aircraft. This development, the Discrete Address Beacon System (DABS) design, has been assigned to M.I.T.'s Lincoln Laboratory as system design contractor.

The objectives of DABS development are to provide the basis for the IPC function, an integral data link between ground and aircraft, and improved surveillance to make possible close-spaced air navigation routes in dense terminal areas and parallel approaches. The goal is to achieve the surveillance and data link function at lowest possible cost and also to yield greater capacity, more accurate data at a higher rate, and better reliability than today's ATCRBS.

The basic design and "breadboard" verification of DABS are now complete, and prototype units are being tested at the F.A.A.'s National Aviation Facilities Experiment Center (NAFEC) in Atlantic City, N.J. Though



Most of the U.S. airspace is now operated as "mixed airspace" with aircraft under either Instrument Flight Rules or Visual Flight Rules; only at altitudes of 18,000 ft. and over are IFR operations mandated. Both IFR and VFR operations are possible at nearly 400 controlled airports; nine major airports have terminal control areas of 15 to 25 mi. dia. In addition, there are over 10,000 uncontrolled airports in the U.S., 3,300 of which have paved runways.

it uses different message formats, data rates, and modulation techniques, DABS is fully compatible with the existing ATCRBS, and an environment of mixed old and new ground sites and airborne equipment will be possible. Studies indicate that general-aviation versions of DABS avionics will cost only several hundred dollars more than existing transponders.

3. Area Navigation

The existing structure of en-route airways and routes within terminal areas consists of straight-line flight segments defined by radial segments of the existing VORTAC network. This limitation to radial segments has imposed extra mileage between certain terminals and has limited the number and capacity of air routes.

Advanced avionic capabilities known as "area navigation" (RNAV) now eliminate the earlier restriction to radial segments; they give aircraft the ability to follow predetermined altitude and time schedules in proceeding from one navigational fix to the next. Integration and utilization of RNAV in two-, three-, and four-dimensional versions is a goal of the Upgraded Third Generation System. Such utilization will provide more routes, permitting possible traffic segregation by speed classes, etc., and separation of traffic headed for metropolitan areas served by several airports according to the airport of destination. Vectoring by ground-based controllers and pilot workloads will be reduced, and aircraft operating costs will be reduced by more direct routes and by optimum climb-out profiles.

The problems with RNAV are related less to equipment development than to proper integration of the capability into the existing ground-based system. An active study of possible features and cost-benefits of area navigation capabilities is now underway, including real-time simulation of possible configurations, at NAFEC. It is possible that by 1980 the en-route airways structure at high altitudes and in those dense terminal areas where positive control is exercised will be almost entirely based on area navigation capabilities.

4. The Microwave Landing System

A new Microwave Landing System (MLS) is now under development to provide more flexible and precise approach and departure paths for civil and military aircraft. It will use a scanning beam or doppler technique at microwave frequencies for wide-area coverage, and it will be useful for airport guidance and also for mobile military tactical operations. The system will provide a high-integrity precise signal and will be capable of installation at sites which cannot accommodate present instrument landing systems because of terrain conditions. The new MLS will make possible steeper glide paths to meet V/STOL requirements, will extend service to many airports, and will aid in noise abatement. Its greater precision will also make possible close-spaced parallel approaches, thus increasing the capacity of many existing airports.

A three-phase MLS development program was launched in 1971 as a joint D.O.T./D.O.D./N.A.S.A. program, with F.A.A. taking leadership. Phase I involved six contractors in technique analysis and design definition. Phase II, now approaching completion, involves four contractors—two each on conventional and

The Computer and the Pilot in the 1980s: DABS and IPC

To control and keep track of the myriad aircraft expected to crowd the skies by the 1980s the F.A.A. has sponsored development of a new computerized air-ground surveillance and communication system, called the Discrete Address Beacon System (DABS). DABS was developed and tested in the Air Traffic Control Division of M.I.T.'s Lincoln Laboratory, under the direction of Herbert G. Weiss; DABS Program Manager was Paul R. Drouilhet. It comprises a system of ground sensors which will provide computerized aircraft surveillance using transponders installed aboard each aircraft.

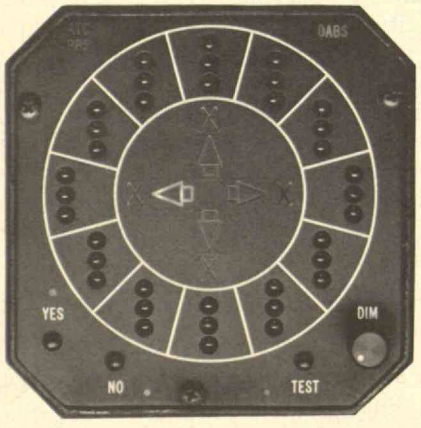
DABS and any specific aircraft can automatically and unambiguously call each other by incorporating in all messages the address unique to that aircraft.

In addition to providing reliable surveillance and communication for en route and landing air traffic control, DABS supports a computerized collision-avoidance system known as Intermittent Positive Control (IPC), now being flight-tested at Lincoln Laboratory. Using DABS-derived position information, the IPC system determines relative position and velocity of all aircraft in a given area. Should aircraft approach one another, the IPC computer automatically warns each pilot and if necessary transmits collision-avoidance instructions via DABS to a display on the pilot's instrument panel.

As shown below, the IPC display consists of 12 three-light clusters arranged in a circle, plus arrows to indicate positive maneuvering instructions to pilots and X's to indicate negative instructions. Each set of three red lights corresponds to one of the o'clock positions familar to pilots. The upper light in each set means the approaching aircraft is above, the middle light signifies at the same altitude, and the lower light, below. A steady light tells that another aircraft is near but not an immediate threat, while a flashing light warns of possible collision. When a flashing light or a maneuvering command is first issued, an attention-getting tone warns the pilot, and he is required to push an acknowledgement button.

In the photograph below, the left arrow, right X, and middle three o'clock lights are lit. A pilot would thus be warned that an aircraft was approaching him from the three o'clock position (90 degrees to the right), at the same altitude, and that he should turn to the left but *not* turn to the right.

In the series of drawings on the next page, an encounter between two aircraft is diagrammed with the computer displays shown.—*D.M.*



Doppler scan—in construction and test of feasibility equipments. By the end of 1974, two contractors will have been selected to proceed with development of prototype equipment using the chosen scanning technique.

5. Automation

An increase in the number of aircraft to be controlled normally requires an increase in air traffic control specialists. As traffic increases, control sectors tend to become smaller and more of the controllers' workload is concerned with the transferring control responsibility between adjacent sectors. Introduction of automation of some functions in the air traffic control system should relieve controller workloads, increase productivity, and reduce the requirements for additional control personnel.

NAS Stage A and ARTS III represent major steps forward in the automation of air traffic control. But they are only a first step. In their present form, NAS Stage A and ARTS III are primarily devoted to collecting, correlating and presenting flight plan, radar, and beacon data; the controller must then use these data in the monitoring and control processes.

But these steps represent a base to which other functions can be added. These higher rungs of an automation ladder will include monitoring of potential problems (conflict alerts), metering and spacing of arriving traffic, and possibly the actual issuance of clearances and instructions by automatic data links.

Achieving benefits from higher levels of automation will not be an easy task. Increased automation clearly will reduce workloads, but the reduced workload may not automatically translate into increased controller productivity. There must be very high system reliability and effective backup provisions, since the confidence of controller personnel will be essential to the full acceptance and utilization of automation.

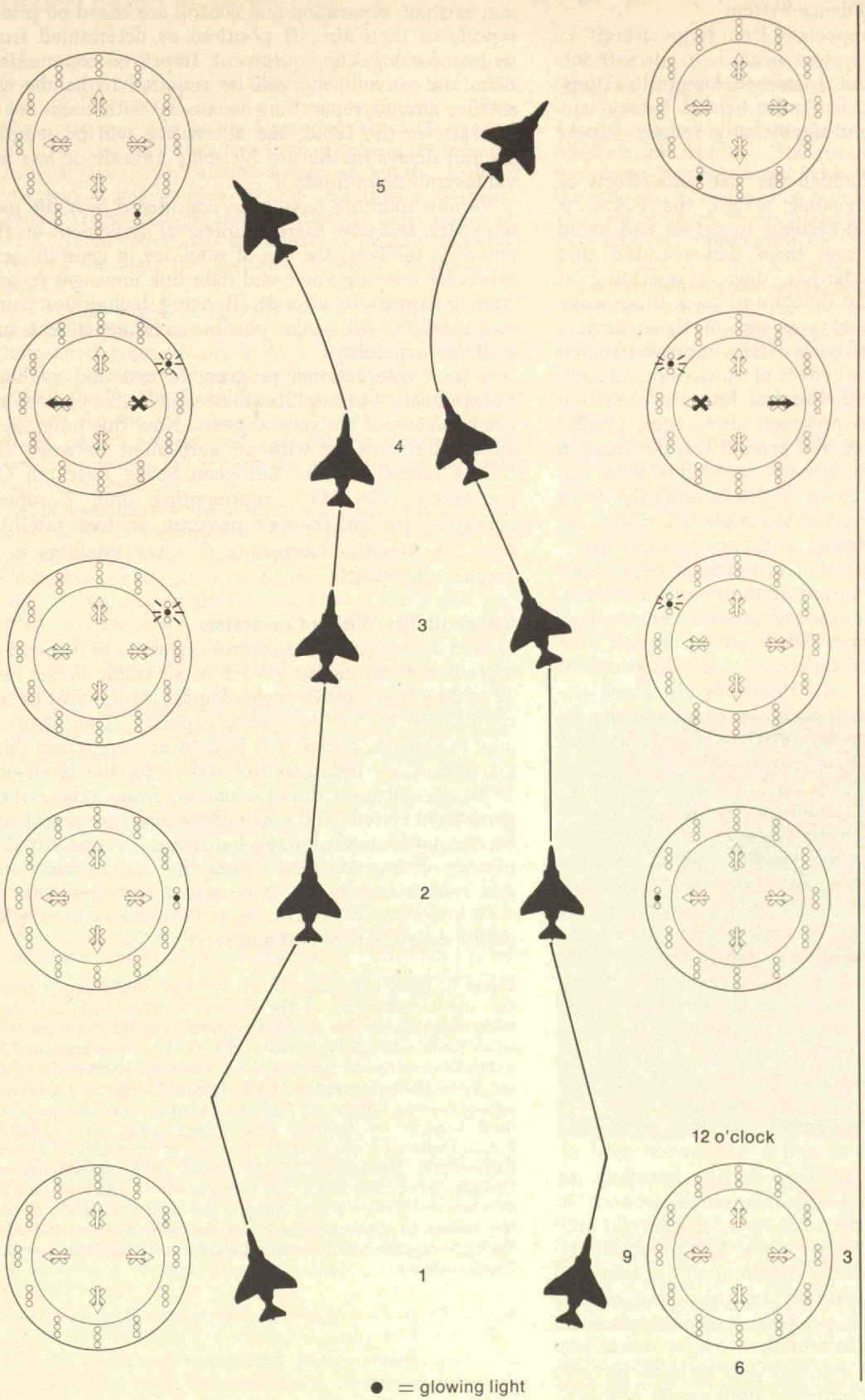
6. Airport Surface Traffic Control

Growing traffic loads and new airport construction which blocks the visibility of airport facilities from many control towers result in new requirements for handling traffic on the airport surfaces. Three needs are identified: improved surveillance of the airport surface, guidance information for aircraft, and improved control of the airport situation.

To improve surveillance, the current airport surface detection radar equipment is being modified and new ground surveillance radars are being developed, with a goal of achieving automatic aircraft tracking from enhanced radar presentations. There has also been a study of discrete sensors, such as magnetic loops placed in runway and taxiway surfaces; indeed, designs for completely automated and integrated control systems using discrete sensors at hundreds of intersections have been considered. At the other end of the spectrum, autonomous control devices working at individual intersections are also receiving attention.

Consideration is being given to the use of ATCRBS and/or DABS for trilateration schemes (three receivers at different locations working together to pinpoint the exact location of each target by triangulation) to provide a clutter-free surface surveillance picture with aircraft identity.

The goal is a modular design for airport traffic con-



5 Collision averted. Planes still within about 2 nautical miles

4 Collision course not changed by pilots. "Do" and "don't" commands issued. Tone sounds; about 30 seconds to collision.

3 Collision course. Flashing lights. Tone sounds; about 45 seconds to collision.

2 Planes in proximity; same altitude but not on collision course. Steady warning light.

1 Pilots are of no interest to one another; no lights displayed. Distance about 2 nautical miles or more, depending on air speed

trol that can be readily adapted to individual airport situations.

7. The Wake Vortex Avoidance System

Trailing wake vortices, especially from large aircraft on approach and landing, present hazards to aircraft following too closely behind. Increased longitudinal separations (up to four and five miles behind "heavy" aircraft) provide safety but significantly reduce airport capacity.

Beyond efforts to minimize the size and effects of these vortices by aerodynamic means, the F.A.A. is working on ground-based systems to detect and avoid these vortices. It has now been demonstrated that pulsed and doppler radar-like devices operating at acoustical frequencies can detect and track these wake vortices, and development and test of these devices continues on an expedited basis. Given improved knowledge of the movement and effect of vortices on aircraft, such a sensor might be the central factor in a system which would detect the presence of vortices, predict their behavior and impact, and present this information in a suitable fashion to ground controllers who can "tailor" aircraft spacings based on this information. On a longer term basis, it is planned to couple this system directly into automatic metering and spacing programs.

This wake vortex detection program is being conducted chiefly at the Transportation Systems Center in Cambridge, Mass. First models of acoustic sensors have been used to monitor some 20,000 vortices created by a variety of aircraft under different wind conditions at John F. Kennedy, Denver, and Heathrow (London) airports, and first results with laser detectors will shortly be available. Whatever system results will be tested first at Kennedy Airport.

8. Flight Service Stations

The F.A.A. currently operates a network of some 400 Flight Service Stations at which general aviation pilots—the primary users—may obtain face-to-face or telephone weather briefings from F.S.S. personnel and file their flight plans. This network of stations is technologically and functionally the same as it was in the 1940s; most facilities and equipment are deteriorating and obsolete, and the system is labor-intensive and unable to meet the present demands for flight services.

A new automated Flight Service Station concept, developed by a joint study team of F.A.A. and the Department of Transportation, proposes three basic elements: a central processing facility; some 30 to 50 full-time, manned key stations; and a nationwide total of some 3,500 unmanned, pilot-self-service terminals at approximately 2,500 locations. When this network is completed, virtually all pilot requests for preflight service (i.e., weather briefings and flight-plan-filing) should be fulfilled through unattended, automated terminals. Pilots will use specially designed input/output devices, such as automatic printers or display tubes, to obtain and file preflight information. Flight specialists will be available in the manned hub stations for en-route communications, emergency flight assists, and system monitoring.

9. Aeronautical Satellites for Trans-Ocean Flights

Oceanic air traffic control and air carrier communications are presently conducted over high-frequency radio circuits which are of relatively low reliability and are approaching saturation in the North Atlantic and eastern Pacific. Surveillance of the oceanic airspace is non-existent; separation and control are based on pilots' reports of their aircraft positions as determined from on-board navigation equipment. Improved communications and surveillance will be required to handle the smaller aircraft separations necessary with traffic loads forecast for the 1980s; the alternative will be lengthy ground delays or the use by some aircraft of less advantageous flight tracks.

Various solutions have been considered over the past ten years, and now there is universal agreement on the optimum solution: the use of satellites in geostationery orbits for relaying voice and data link messages to and from transoceanic aircraft. Ranging techniques using two satellites will make possible an independent surveillance capability.

A joint international program to test and evaluate the application of satellites to oceanic traffic control has been considered for several years. Now this program is approaching reality with an agreement between the U.S., Canada, and the European Space Research Organization (E.S.R.O.), representing nine European countries, for an AEROSAT program of two satellites over the Atlantic. Launching of these satellites is to begin in mid-1978.

Compatibility Within Constraints

If the nation's air traffic control system is to respond to a predicted continuing growth of air traffic in the next 10 to 20 years, a major technological thrust must be accomplished to double system capacity. That effort is now in process, and it will lead to an "upgraded third generation" air traffic control system for the 1980s and 1990s. It will be a direct evolution from today's third generation system, and much of the new equipment will be compatible with today's hardware; existing capabilities are being extended within the current functional and system framework. Nine major developments are now underway by F.A.A. to achieve the desired goals within constraints of cost and safety.

David R. Israel is Deputy Associate Administrator for Engineering and Development at the Federal Aviation Administration, with responsibility for F.A.A.'s research and development work in air traffic control. Problems in that field have monopolized his interest ever since he graduated (in electrical engineering) from M.I.T. in 1949, first at the M.I.T. Digital Computer Laboratory, then at Lincoln Laboratory and Mitre Corp. (where he was Technical Director of Systems Engineering), and since 1970 at F.A.A. (where he was formerly Director of the Office of Systems Engineering Management). Mr. Israel holds the Meritorious Civilian Service Medal of the Department of Defense (for the development of new sensor systems and their application to military actions in Southeast Asia) and has twice received the Silver Medal Award for Meritorious Achievement of the Department of Transportation.

What Role for a Traffic Situation Display?

The Airborne Traffic Situation Display (ATSD), which would give to pilots a cockpit display of the air traffic around their aircraft, has an auxiliary, supporting—rather than primary—role in the Upgraded Third Generation air traffic control system now in development. But the results of simulation studies sponsored by the Federal Aviation Administration at the Electronics Systems, Flight Transportation, and Man-Vehicle Laboratories at M.I.T. argue that ATSD could have a primary role, according to Mark E. Connelly, Research Engineer at E.S.L.

The current plan to upgrade the air traffic control system calls for almost total reliance upon centralized, automated, ground-based facilities. It is an approach that is "not without technical, operational, and economic risks," thinks Mr. Connelly. "It minimizes the opportunities for the pilot to actively participate in the air traffic control process, and such participation may turn out to be essential to achieve the desired performance at high traffic densities."

The essential feature of ATSD is a traffic situation display which is presented to the pilot en route and as he proceeds through the terminal control area at his destination. The top of a computer-generated moving map corresponds to the heading of the pilot's own aircraft, and his ship's position is centered on the display screen; hence the map rotates and translates with respect to a fixed "ownship" symbol. It gives the pilot a complete picture of the sky in his vicinity—the position, movement, identification, altitude, and landing sequence numbers of other aircraft; runway configurations; and the locations of navigation aids. He also receives a continuously updated map of the terminal route structure, laid out to segregate arriving and departing traffic and to utilize the airspace efficiently.

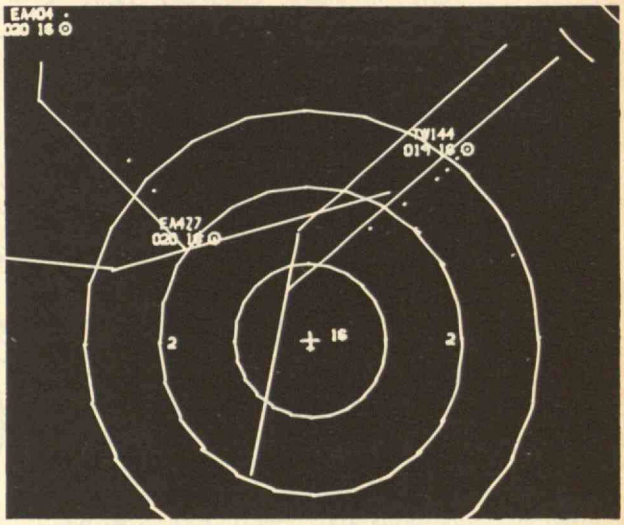
Two distinct control modes have been suggested for the terminal approach phase of flight. In one, the ground-based air traffic control computer "derandomizes" the traffic flow by generating a sequence of speed and path control commands which are transmitted to each pilot for execution. For example, the command "S200" displayed in the cockpit would call for a speed adjustment to 200 knots; "H111" would mean a new heading of 111°. In the second control mode, which is favored by the ATSD proponents, the air traffic control computer assigns to every aircraft a nonconflicting schedule of arrival times at each waypoint in the airspace structure, with the responsibility for adhering to the schedule and structure vested in the pilot.

Over a three-year period, an extensive series of tests with airline, military, and commercial pilots as subjects have been run on a 707 cockpit simulator at M.I.T. to evaluate the operational value of the ATSD. The airspace structure of Boston's Logan International has been used to provide a realistic approach environment for these tests.

Reporting results of the simulator studies, Mr. Connelly told the I.E.E.E.'s NEREM meeting in Boston this fall that in general, the cockpit display enabled pilots to merge and to space themselves in trail more closely and much more precisely than is possible with present-day radar vectoring techniques and that the resulting pilot workload did not exceed acceptable limits. Pilots on simulated flights have been able to maintain positional accuracies within 0.1 mi. (3 sec. flying time at aircraft approach speeds) and touch down almost precisely on schedule, he reported. The controller-pilot communications were greatly reduced in number and duration when the ATSD was available. In a discrete address communications environment, it was found that the ATSD is a more-than-adequate replacement for the voice party-line: The subjects had a better knowledge of aircraft positions, committed fewer gross errors, and were much better at detecting conflicts. In fact, with no spacing task and more intensive training, emphasizing conflict detection, pilots testing the ATSD were able to detect all of the scenario conflicts.

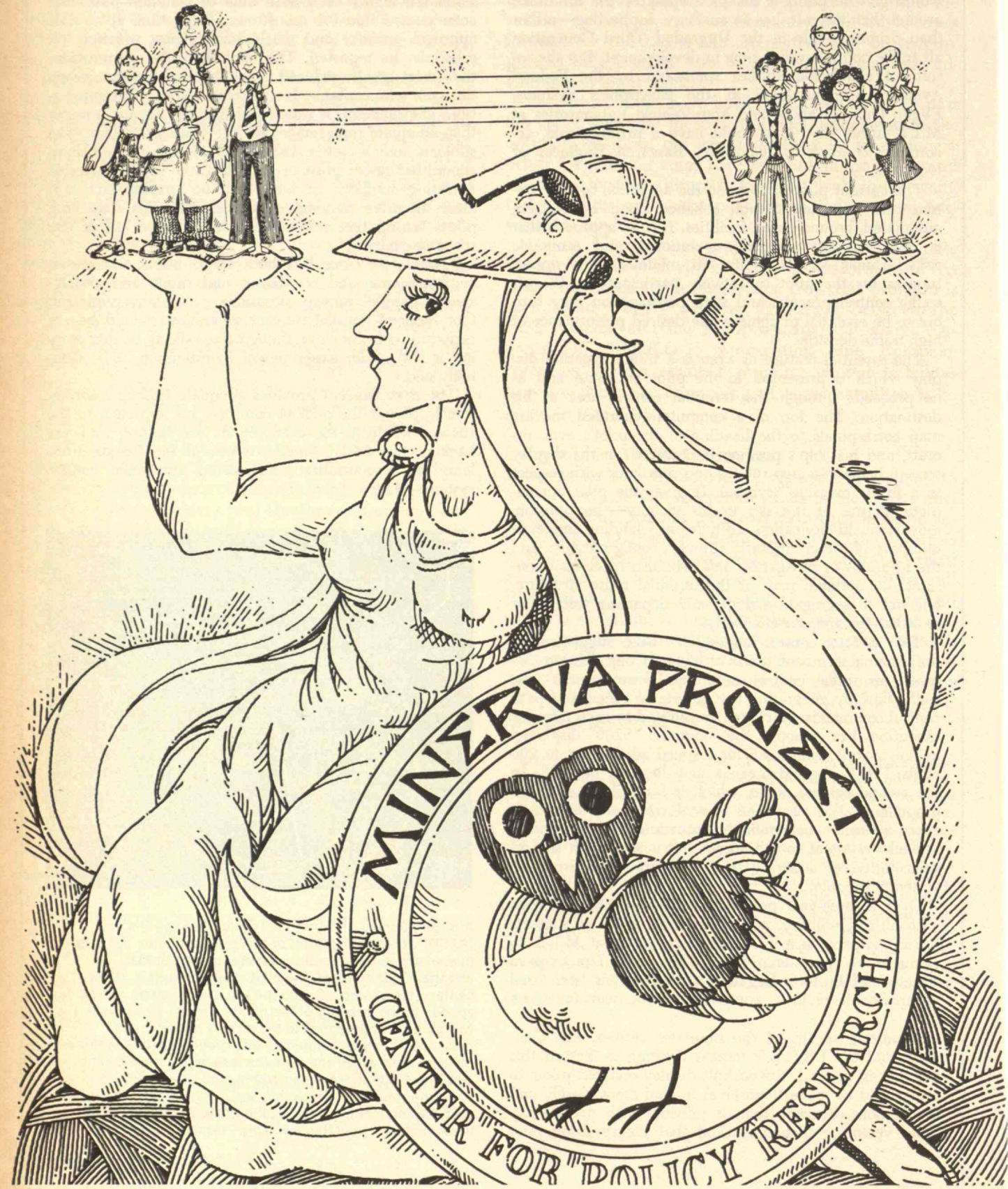
"These test cases had both single pilots and crews, conflict alarms and no alarms, and single and closely-spaced parallel runway situations. . . . Many pilots felt that reduced parallel runway separations would be acceptable with the ATSD, though the validity of this opinion is still under experimental investigation," Mr. Connelly said.

The ATSD concept provides adequate backup information to permit the pilot to complete his approach to the runway safely in the event of an ATC failure. Fail-safe backup, says Mr. Connelly, is one of the "major problems" in a centralized, automated air traffic control system.—*J.M.*



A pilot watching an Airborne Traffic Situation Display (ATSD) would find in front of him a presentation such as this. In simulations used by several groups at M.I.T. to test the ATSD concept, the pilot's own aircraft is at the center—the symbol 16, and the top of the "map" corresponds to the heading of the pilot's aircraft. Shown are two parallel approaches to the airport runways; the positions, identities, altitudes, and ground speeds of three other aircraft within the area (for example, Eastern Flight 404 is at 2,000 ft. travelling 160 m.p.h.), tracer dots to show the routes on which they are approaching the airport, and concentric circles to indicate the ranges of all these features from the "ownship" symbol.

Social scientists and engineers must learn to work together on today's societal problems. That goal—so easily stated and rarely achieved—is being successfully sought in a study of audience participation in telecommunications.



Illustrations by Ed Parker

An Engineer-Social Science Team at Work

Amitai Etzioni
Professor of Sociology,
Columbia University;
Director, Center for Policy Research

We commonly recognize the complexity of our numerous societal problems by suggesting that their solution requires interdisciplinary teams in which are combined the experience and knowledge of many experts in many fields to face all the main elements of a problem. And we often lament, as James Carrol quoted by Harold Orlans, that the "present compartmentalization of knowledge . . . in the form of academic disciplines is not coincident with social need. However useful this compartmentalization may be for the inner development of knowledge, it is only marginally useful for the resolution of social questions."

But we also often lament that interdisciplinary teams have a hard time working together; as Mr. Orlans writes, "Universities have had great difficulty in conducting successful interdisciplinary research. . . . [And] . . . while research institutes have been more (they could not have been less) successful than universities in organizing interdisciplinary teams, the frequency with which such teams are utilized and the extent of their success is commonly exaggerated." For example, Bruce Smith has reported that interdisciplinary research at Rand Corp., "far from becoming steadily easier and more effective, has actually grown more difficult in recent years." One indication of these difficulties is that such teams are rare, while monodisciplinary work is common.

I would like to discuss one instance of effective team work which I believe casts some light on the opportunities as well as the issues involved. It concerns a research project on telecommunications being worked on by both social scientists and engineers. The study has not resulted in any sensational breakthroughs; however, the problems of working together were effectively reduced and the results are "products" that seem superior to those which a mono-disciplinary team could have produced.

The Setting—a Multidisciplinary Center

The work reported has been conducted at the Center for Policy Research, a nonprofit research corporation in New York City. The Center's staff includes sociologists, psychologists, economists, engineers, systems analysts, a lawyer, and workers trained in other disciplines. As the research staff has no more than fifty persons, they know each other relatively well. There are no mono-disciplinary departments, chairmen, deans, or reward systems. The Center carries out projects in most domestic policy areas financed chiefly by grants of government agencies, foundations, and private industry, in that order. It does no classified research and considers society as its ultimate client.

Attempts to keep all the 50 members of the staff in dialogue with each other in Center-wide meetings (a desire frequently voiced by staff members) resulted, without exception, in boring, mechanical affairs, which the majority of the staff soon vetoed by staying away. Intensive dialogues take place among individuals whose offices are adjacent or *who work in the same problem area* in teams of two to nine; or such dialogues occur in "marathons" (one lasted eight hours throughout a Sunday), in which 25 to 35 staff members participate—a research team plus others interested in the subject area. The rest of the Center-wide activities, aside from occasional "business" meetings, are parties which bring out the staff, spouses, and friends. All this had led me to suggest that the well established sociological law which expects that "formal groups" (in which relations are "cooler" and more work-oriented) will be larger than "informal" groups (which are "warmer" and contain friends and peers) needs to be reversed: it might be most effective for research centers, at least, to have small, problem-oriented teams or formal groups and large, informal ones.

Developing Participatory Technology

One major project of the Center is to develop an electronic system which will allow people dispersed in space to conduct a dialogue with each other in *groups* and to register their views as a group, in the same way a group is able to do when meeting face to face perhaps in a town hall. Technology is sought to increase authentic participation, create a democratizing effect, and reduce alienation. The project, named Minerva after the Roman goddess of wisdom, is supported by RANN (Research Applied to National Needs), the new division of N.S.F., the National Science Foundation. Dr. Stephen Unger and I are co-principal investigators; Dr. Unger is Professor of Electrical Engineering and Computer Science at Columbia University, where I am a professor in the Department of Sociology. The Minerva research team includes four social scientists and four engineers. (The study referred to is supported by N.S.F. grant No. GI 29940)

The work on conference calls provides illustrations of the teamwork discussed below. The initial requirements for these calls, in terms of social science, are to provide for a flow of dialogue and for tallying of res-

ponses. Here are some of the questions we have had to face: How will requests "for the floor" be transmitted? How will votes be tallied? How can the "tower of babel" condition (many parties talking at once) be avoided? How can participants be provided with a "sense-of-the-group"—how others feel (previous social science studies show that without such cues, people may be reluctant to take stands)?

All these "needs" are served through the use of non-verbal cues when groups meet in face-to-face town hall meetings; for example, a participant raises his hand to request the floor or to vote; he stares (to quiet the interloper), he scans faces as well as nods (to assess the group's reactions), etc.

At first the social scientists of the Minerva team sought mechanisms that would be as close to the *natural* group processes as possible. If members of dispersed groups could see each other, for example, say by using picturephones, they might be able to work together as people do in face-to-face groups.

The engineers contemplated various devices to respond to this notion of the social scientists: let the speaker's face be displayed on the conference circuit for all to see (but we all realized that this would not meet any of the suggested needs except the communication of the speaker's non-verbal cues, such as facial expressions, movements of the hands for emphasis); use a split screen showing all the participants' faces (that might do nicely for the social needs identified above, but we would need a giant screen for a group of 30, or even 12, if the faces of all the participants were to be recognizable); have a scanning device which would display only the face of one participant at a time but which would scan all of them; or have half the screen devoted to the speaker, the other half to such scanning (this suggestion seemed to bring the design closer to what the social scientists thought was necessary).

At the same time we began to wonder whether or not we were correct in our basic approach. We were trying, in effect, to *reproduce* in another medium all the same effects available in the first one; perhaps instead we should seek *electronic equivalents* to the social-psychological processes—electronic steps which would answer the same needs but not be identical or even similar in form. Thus when a person wishes "the floor" in a face-to-face group discussion, he cues the chairman, or all present, by some non-verbal cue such as raising his hand. In a picture phone this could be approximated; but why not give each participant a little button with which he could turn on a small light (or flash a number), which would serve the same purpose as raising his hand? Similarly, such cues could be used to assess the group's sentiment about what is being said and where the discussion is moving, without any scanning of faces. At this point I suggested equipping each telephone in our laboratory with a cue box that would allow participants to request the floor and to register approval or dissent. Later an integrating unit for tallying the responses was added and a gavel for the chairperson is planned.

At this point, Dr. Unger raised a major consideration which was not alien to the social scientists but which they could not *really* worry about, let alone solve: if Minerva was to be used on a large scale, the cue-box idea would require modifying a tremendous number of telephones. This would take years, maybe decades, and great expense; it suggested a task which could hardly be welcomed by overburdened telephone companies. On the other hand, if only some telephones were modified, the use of the system would be limited because many groups who would wish to meet on conference circuits would have some members with assisted and some with unassisted telephones.

Two Rules from Technology

Professor Unger suggested that we should try to follow two rules: see how far we can go without modifying the "normal" telephone network; and try to suggest changes; if necessary, whose implementation would be concentrated at telephone exchanges rather than at home terminals. After additional deliberation it was suggested that "flashing" (opening and closing the circuit to signal the operator) in dial telephones and, even better, pushing the buttons of touch-tone telephones could be used for the suggested purposes. The engineering members of the team are now trying to work out the circuits necessary to use existing telephones in this way by modifying telephone exchanges to give them the capacity to "read" and transmit the cues. The team has only been working on this mission for a short while; therefore, it is not yet clear if this approach will pay off.

Experiments—Problems and Successes

While our discussions were going on, experiments were being run in our laboratories.

The first experimental conference call groups met without any technical assistance. When small (nine members) homogeneous groups were chosen and were given a chairman, and when a "midline" task (not very easy, not very difficult) was assigned, the groups worked quite well and effectively—they communicated easily and reached decisions—without technical assistance. However, when the task was made more difficult the general complaints about the unassisted system rose. Richard Remp, who conducts the experiments, reports that the percentage of participants who indicated that they were "always" able to follow the discussion fell from 48 per cent on the easier task to 34 per cent on the more demanding task. Similarly, the percentage of participants who indicated that they could get the floor "very easily" fell from 20 per cent to 13 per cent. While 17 per cent of the participants characterized the discussion on the easier task as "very effective" in exploring the topic, only 6 per cent of the participants on the more demanding task chose that description of the discussion. It was of particular interest that a fair number of the participants in both tasks spontaneously mentioned their need for a means of more clearly identifying the speaker.

Meanwhile, to test the basic notion that electronic equivalents could better serve our aims, the engineers followed my suggestion by developing a cue box, which is now being used in experimental conference calls in the telecommunication laboratory of the Center. The box might be said to simulate the conditions which would exist if touch-tone phones could be used for cueing. The cue box also provides a model of the technical assist that may be used if efforts to do without special assists fail, and its development has confirmed our main thesis—the value of a close, continuous dialogue across disciplines.

The first cue box was designed to provide a button, a switch, and two lights per participant. The button is to control one light which lets the chairman know that a participant wishes the floor *without* the request being carried verbally, which would interrupt the dialogue. The switch signals assent if pulled up and dissent if pulled down; the second light is used to register both feelings: short rapid flashes indicate approval (like applause); long flashes—dissent (like a boo). Each participant's cue box panel also has two lights for each other participant; thus each participant can see what all other participants feel and if any has requested the floor.

At this point, the social scientists started to wonder about the social consequences of a technology which actually accelerated the natural process it merely sought to reproduce. In a real-life group one rarely if ever knows at all times exactly where each member "is" with reference to the issue under discussion; with our cue box every member receives every other member's signals constantly. We hypothesized that greater individual and aggregate visibility might inhibit participants who are clearly in a minority from expressing their views lead to decisions before people have had a chance to fully air their ambivalences, or reduce the chances for give and take (individuals, once they have identified with a position, may be reluctant to shift).

The engineers suggested two technical adaptations to test for these postulated undesirable influences (do they really exist?) and to partly eliminate their effects. Other devices developed by the team go beyond that. But one thing at a time.

The "request-the-floor" button, at first, was to be fixed, that is, once you push it your request is registered, and to undo it, you have to push it again. Now the engineers suggested to wire the "assent-or-dissent" signal so that it erases if you stop pushing it. In this way technology "encourages" people not to freeze their position. (Who wants to hold a switch on "dissent" for an hour, unless he really is very strongly opposed?) Of course, when the signal is used for voting purposes and responses are to be tallied, a "freeze" procedure is used, but this occurs only at a stage when the group—or at least the chairman—is ready to vote, which is one form of registering views for which the cue box is incontestably useful.

Second, the engineers gave the chairman a central switch by which he or she may cancel all visibility (except each participant's own signal). Thus the chairman can eliminate each participant's feedback from others, withholding individual and aggregate visibility for whatever period is desired either by the chairman or the group. This device can be used, for example, to be sure that discussion is uninhibited during the first half of the meeting or the first meeting of a series, or until the group votes that it has had enough dialogue and is ready for a first "straw" vote.

Testing of the cue boxes revealed different behavior pattern, which approximates that of a natural group, when the number of participants increased. While it was easy for members of small groups (of, say, seven members) to recall what each person had said via their signalling lights, when the group grows to say 25 to 30, each member can see only *group patterns* (lots of dissent lights, lots of assents, many switches, etc.); he is not able to identify a position with each member of the group. He could keep track of how X or Y felt, if these were viewed as particularly important persons, but he could not keep track of everyone.

One day an engineer brought to the laboratory a device which translates electronic cues into optical bars. Seeing it flash led me to realize that it could serve for a more radical alteration: the individual lights could be replaced by a summary indicator giving a group visibility somewhat like the figures on an election-night television screen. However, our experience suggests that while this approach has certain virtues, it also prevents individual and subgroup recognition and may project a more monolithic indication than the situation warrants. For example, if many members of a group are undecided, 10 out of 30 shifting their views from "yes" to "no" and 10 from "no" to "yes," the summary indicator would continue to read "20 favor," giving no indication of indecisiveness to the participants.

What about automating the chairman? If indeed large numbers of groups are to be in dialogue, including people who have not met before and who may be assigned to a group by a computer (on the basis of their indication of the kind of people they want to talk with), there will be difficulty in electing or otherwise choosing a chairman.

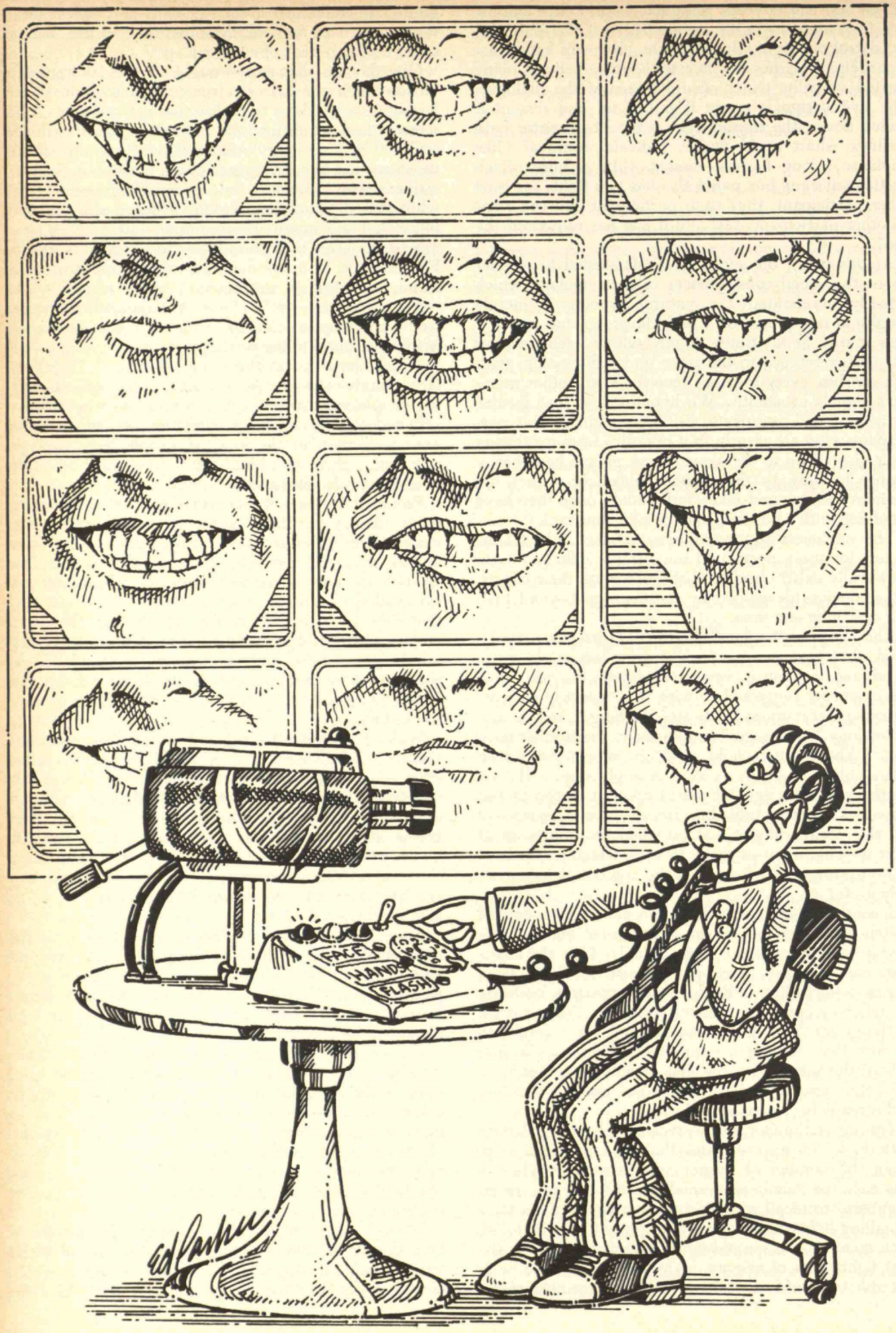
Professor Unger suggested one day that a mini-computer at the telephone exchange could replace the chairman by receiving the "I-wish-the-floor-next" cues and assigning the floor in the order of the requests. The airlines are now using such a device when lines are overloaded to tell callers that all agents are busy and that callers will be assigned an agent when their turn comes. This could be adapted here. Moreover, Professor Unger pointed out, the computer could inform callers of how much time they would be alloted, the amount of time depending on the size of the backlog stacked up.

Well, I wondered, such an automated chairman sounded quite insensitive. A real-life chairman often does not allot the floor mechanically, on a first-come, first-served basis. A good chairman takes many things into account: whether or not the person had the floor before; if he tends to be representative; if he tends to be verbose and repetitive; if his side has just been heard three times ("let someone speak against 'it' "); whether or not others can be drawn into conversation (e.g., people who are shy); etc.

Fine, replied Professor Unger, we could give the automated chairman most of these guidelines. For example, no one would be chosen twice before every person who sought it had the floor once; the floor would be assigned alternately to those who cue assent and dissent, or whatever.

I was skeptical because I remembered that a chairman often follows these rules implicitly and intuitively; to make them explicit or visible may cause many strains and conflicts. Professor Unger then suggested that one need not announce the guidelines followed by the chairman either, although there might be some social merit in doing so—or at least in being able to do so. We decided to try an open and an opaque automated chairman.

What I seek to highlight in reporting this process is how the interaction between the engineers and social scientists identified several technological options which clearly differ in their social consequences. Without


GRUE
HANDY
FLASH

close give-and-take the engineers might well have settled for one of the options, having had no reason to identify others, and the social scientists might have felt there was no way to deal with the side-effects of the one available. To put it simply, we are all richer for the dialogue we have shared.

Finding the "Dialogue Barrier"

We already know from these experiments and from those conducted by a New York enterprise called Tele-Session that groups of 30 can conduct an effective dialogue on conference circuits. The question we ask, as we seek to approximate town hall meetings, is what is the upper limit; where is the "dialogue barrier"? Reference here is to the number of people "hooked" to the same channel, who all can hear each other and can effectively participate as if they were in one hall, where the audience reaction—restlessness, cheering, booing, careful attention—affects spectators and is part of the process in which the group makes up its mind.

This dialogue barrier becomes crucial when we plan for the larger groups for which two-way cable television is to be used. One strategy for studying dialogue barriers would be to equip two-way CATV participants with a return audio capacity; that is, a microphone could be placed in each home so participants could speak to each other about the issues being discussed on CATV. But the size of the dialogue barrier will be affected by the "communication-manners" of the participants; the better they are, the more people can participate. Could we do something to hinder any one participant from disturbing the whole meeting—a kind of electronic equivalent to staring down disruptors in a public meeting?

An engineer suggested that to discourage these obstructors we could build a system in which people could hear, see, and receive cue feedback; but their microphones would be activated only when they are given the floor by the chairman. We quickly came to call this the "harsh gavel."

The social scientists suggested that we need a microphone to pick up audible reactions from each participant—such as grunts of approval or disapproval; but no participant should be able to obstruct the meeting by shouting or tapping his mike. At the same time, it would be quite appropriate for 50 or so participants to be able to make the kind of blocking noise they would make in a town hall.

The engineers met this suggestion with the idea of a "meek gavel;" each person would have a weakly amplifying microphone, and his microphone would be turned up when he had the floor. (We are now looking for such a microphone; while the concept is clear, we do not know if the equipment is available.)

The Minerva project is still in full swing. Among the topics engineers and social scientists are now grappling with are alternative methods for tallying responses, arranging conference circuits, switching CATV viewers, activating television screens, and formulating rules of access to the new technology. But these topics are still being evolved; while it is premature to decide which technology is best, or best under what conditions, it is clear that the inter-disciplinary team is working hard to find the optimal solution. This discussion may suffice to illustrate the close interaction between the two disciplines.

The Forces at Work

We believe that crossdisciplinary work is appropriate at the Center for Policy Research for several reasons.

Some of these lie in the organizational arrangement and the participants' orientations. The Center is unlike a university department or professional school; it is a cross-disciplinary unit, and these tend to be regarded as "second class citizens" in terms of budgets, rewards, and status. The Center for Policy Research is wholly interdisciplinary and considers such work a virtue—indeed, essential for handling our societal problems.

Second, the Center and the Minerva team are more committed to serving the society than to enriching basic research knowledge. They are quite happy to add to the coffers of our collective knowledge; but they care most strongly about being of value to the "real" world. This attitude makes the group problem- rather than discipline-oriented; in turn, this brings members of the different disciplines together.

Closely related is our focus on a concrete problem rather than on abstractions, models, or measurements. People working with applied or policy problems within each discipline are closer to workers from other disciplines than to the theoreticians or measurement builders in their own fields. Perhaps even more important is continuous, frequent, intimate interaction. There is almost daily give-and-take within a fairly small group; without this, the disciplinary blinders are difficult to overcome, and team members tend to talk *by* each other rather than *to* each other. We find that each member of the group must become aware of the implicit assumptions which each makes about the others' disciplines (many engineers tend to assume that their colleagues are rational men, that social scientists are non-rational ones). Basic concepts have to be shared; thus as I learned to talk about frequency-division vs. switched cable systems, Professor Unger began referring to "primary" groups.

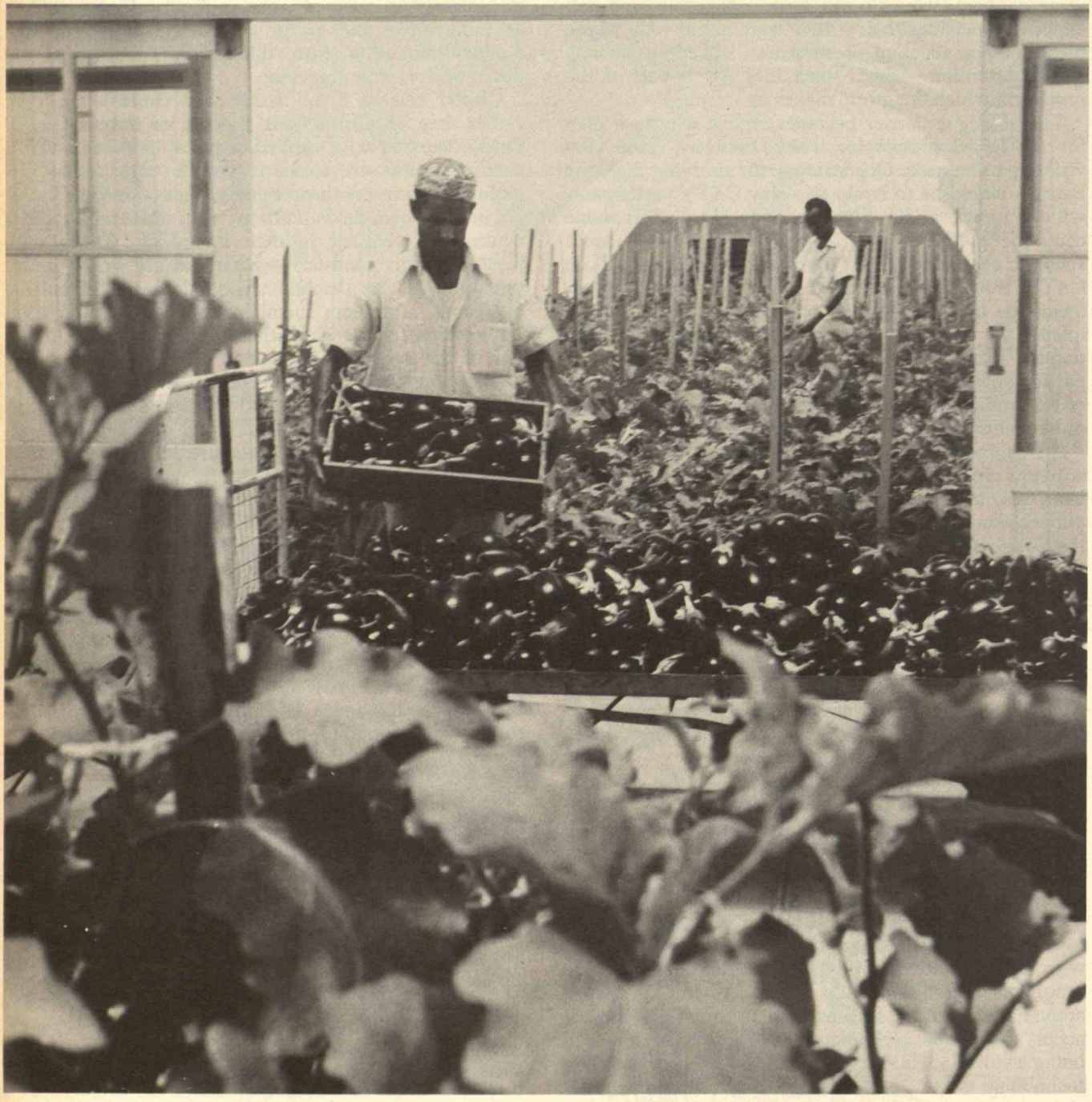
The importance of such teamwork lies in the fact that most problems we face today have social *and* natural science elements. If the two elements are dealt with separately, the implicit hope that someone will later be able to synthesize the mono-disciplinary findings is often frustrated. The development of true cross-disciplinary work may not be an essential prerequisite for defense and space missions; but it seems to us essential—and possible—for most domestic missions.

Suggested Readings

"Minerva: An Electronic Town Hall" by Amitai Etzioni in *Policy Sciences*, December, 1972.
"The Efficacy of Electronic Group Meetings" by Richard Remp forthcoming in *Policy Sciences*.
"The Secret Power of Telephone Conference Calls" by Amitai Etzioni in *Telecommunications*, October, 1973.
"Two-Way Communication: A Design Analysis of a Home Terminal" by Noam Lemelshtrich, forthcoming by Sage Publications.
"Economic and Legal Foundations of Cable Television" by Leonard Ross, forthcoming by Sage Publications.
"Policy Research" by Amitai Etzioni in *The American Sociologist*, June, 1971

Amitai Etzioni was born in Germany and studied at Hebrew University (Jerusalem) and the University of California; he has been at Columbia since 1958. His research and writings span a wide range of subjects related to societal organization and social change, including issues through which science and technology affect human institutions.

Under translucent cover, desert sands are being made to yield crops of surpassing quality and quantity. The economics, however, are competitive only in a few cases. With some refinements in existing technology, controlled-environment agriculture can be given a substantial lift.



Spectacular eggplant harvests from the controlled-environment "desert food factories" in Abu Dhabi have enabled that nation to export to other countries, countries which have traditionally provided Abu Dhabi with food. Higher vegetable yields than from even conventional greenhouses have been produced due to the warm climate and year-round sunshine in this oil-rich and water-poor country. (Photo: Manley, Tucson)

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Desert Food Factories

If the world's growing hunger is to be satisfied, means obviously must be found for increasing productivity from the finite land that is available for farming. The so-called "Green Revolution" in grains, which is not without its inherent limitations, at best offers a partial solution. Many other innovations will be prerequisite to feeding the explosive population. One promising response to this challenge may be seen in an improbable place: tiny Abu Dhabi, a sandy Arab Shaikdom best known for petroleum. Several times in the past two years, cucumbers, tomatoes, eggplant, and peppers were air-freighted into Lebanon from Abu Dhabi. Because none of these trial consignments—which were of exceptional quality—exceeded a ton in weight, the transactions caused no noticeable excitement among international traders. To agriculturists, on the other hand, they were worth at least a footnote for two reasons: the food was extracted from one of the least arable locations on earth, and Abu Dhabi always had imported vegetables, many of them ironically brought from Lebanon.

What enabled this cornucopian transformation was an artificial oasis that scientists and engineers from the University of Arizona have superimposed on a parched islet off the Arabian mainland. There, desalted seawater, distilled with waste heat captured from generators, is used to irrigate vegetables inside plastic-skinned greenhouses in which the microclimate can be regulated. All of this may seem reminiscent of *Dune*, a 1967 Frank Herbert novel that ecology buffs have evangelized as almost a new *Book of Revelations*. In *Dune* the locale is a waterless planet bereft of any verdure save that in an indoor garden. In Abu Dhabi the nonfictional indoor gardens promote fertility where dust storms, heat, and aridity preclude ordinary agriculture, and the low, sparse shrubs barely sustain a few browsing camels.

This concept began to evolve half a world away, in Tucson, at what now is the University's Environmental Research Laboratory. Our sole interest, initially, was in a theory for the low-energy humidity—cycle desalination of seawater. A small working model was put together on a large lot that once had been the campus polo field. Then, in 1962, a 2400-gallon-a-day unit was fabricated on the Gulf of California at Puerto Penasco, Sonora, Mexico, a shrimp fishing and boat-building settlement 220 miles southwest of Tucson. This was a joint venture with the University of Sonora, the genesis of bi-national cooperation between the two institutions that continues still at Puerto Penasco.

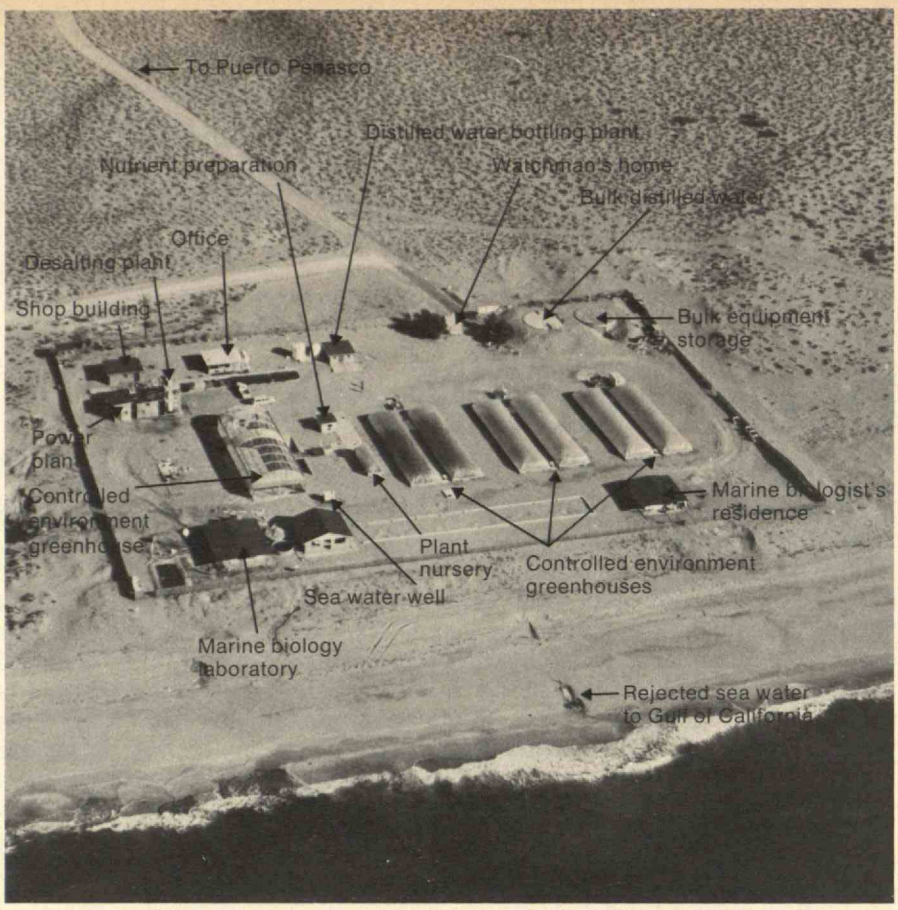
Sunlight originally provided the energy for the desalting process, although solar energy later was abandoned for a more immediately practical source: the waste heat from the two diesel-electric generators at the research station. Internal combustion engines, as is well known, dispel to the atmosphere much of the energy they produce. So, at Puerto Penasco, heat exchangers—recovery mufflers—were attached to the exhausts and water jackets of the generators, and that heat then was harnessed for the distillation of saline water. The desalting unit worked well enough, and even yet might prove to be feasible for certain small-scale applications.

Meanwhile, it had become clear, though, that any desalted water probably will remain too costly for conventional irrigation for the foreseeable future—and particularly in arid areas where evaporation and transpiration are prodigious. A crop in the desert may consume up to 100 times its weight in water each day—most of it merely to keep cool. An obvious question was whether there might be a way, by creating a manipulatable milieu, to till vegetables on a desert coast with a minimum expenditure of desalted water. As it turned out, there is. Biologists at our laboratory determined that plants grown in essentially 100 percent relative humidity demand less than a third of the water required by those in a humidity of 35 percent. In practice, though, this is easier theorized than done.

Lighting and Cooling, and Tom Sawyer's Whitewash

While sunlight is essential, of course, to photosynthesis, excessive radiation sometimes overheats leaves. When that happens, three of nature's fail-safe systems cool them: convection, re-radiation, and transpiration of water. Transpiration may be reduced simply by adding humidity—which lessens the vapor-pressure gradient between leaf and atmosphere—and cooling may be maintained by substituting more convection and re-radiation. Thus, the leaf temperature and consequently the convectional and radiational transfer increase, and a slight rise occurs again in transpiration. As long as this leaf temperature is not high enough to impair productivity, there is no problem. In a controlled ambience, however, where one objective is optimum sunlight, the equilibrium temperature, with only natural convection, can be extremely high. Cooling becomes crucial.

If one wishes to alter the environment, he must commence, patently, with small, confined spaces. Accord-



An air view of the Puerto Penasco facility shows the inflated plastic "greenhouses" covering the growing areas. Air is circulated through the growing enclosure, and maintained at the relatively cool temperatures between 70° and 80° F. through contact with seawater from the Gulf of California. Part of the seawater from the seawater well is piped to the desalting plant, and the distillate is mixed with nutrients and sent through a trickle irrigation system to the plants under the plastic.

ingly, the Environmental Research Laboratory, with Rockefeller Foundation funding, erected and evaluated greenhouses of diverse materials and configurations—first on the old polo field and then in Mexico. Structures of air-inflated plastic appeared promising. The plastic would be relatively inexpensive, the covers easy to install, and there would be no supports to inhibit sunlight. We chose a 12 mil polyethylene, with a yield strength of about 1,400 p.s.i. It was treated to filter out ultraviolet radiation, which has no photosynthetic utility and simply adds heat to the greenhouse.

Eight pneumatic polyethylene "tents," resembling long, translucent quonsets, were inflated at Puerto Penasco in 1966. Each was 100 feet long and 23 feet wide, and anchored to a concrete curb. To enhance the environmental control, that is, to form a more or less closed loop, the half-cylinders were put up in pairs; each pair was connected front and back by concrete tunnels. Early in the first summer, it became obvious that no crops within the enclosures could withstand the withering sun. To diminish the radiation load, therefore, the greenhouses were shaded, i.e., they were sprayed with Tom Sawyer's whitewash—a mixture of water, gypsum and glue. This protection was sufficient. Since the expected lifetime of the plastic at Puerto Penasco was only 12 months, the plastic cover could be sprayed with shading compound late in the spring and replaced for another year at summer's end. Changing plastic covers was an elementary procedure, a three-hour job for four men. Inflation, which takes less than two minutes, was done with the circulation system, two ¾ h.p., 10,000 c.f.m. belt-driven propeller fans.

Once inflated, little pressure was required to keep the polyethylene canopies taut. A primary 1/6 h.p. centrifugal inflation blower maintained a positive pressure generally of .01 to .02 p.s.i., albeit, this was a function of ambient wind velocity. When wind speeds reached about 20 m.p.h., the covers were stiffened by an automatically switched-on, 1-horsepower blower that increased the pressure to about .03 p.s.i.

The air flow created by the circulation system began in the back of one house. Fans forced the air through a tunnel to the adjoining house and up through packed-column heat exchangers, low honeycomb-like stacks of corrugated asbestos through which seawater was sprayed. After the moistened current flowed the length of the house, it was deflected through the front tunnel and back down the opposite unit to the fans again. This movement, on the order of 20,000 c.f.m., continued in a ceaseless pattern.

Pressure blowers inserted 1,000 to 1,800 c.f.m. of outside air into each house. Inside, because the cycle was virtually closed, the trapped air swept every two minutes through the spray of the packed column, becoming almost saturated. Humidity hovered close to 100 per cent. Both it and the air velocity, which prevents stagnation at leaf surfaces, were important to environmental control.

Water for the packed columns, like that for the desalting process, was pumped at a year-round temperature of approximately 78°F. from a seawater well. Thus, temperature in the greenhouses could be controlled to a considerable extent by managing the flow of the seawater through the packing. The column was not

Controlled-environment yields versus field-grown yields in tons

Vegetable	Field-grown yield (U.S.) acre/crop	Abu Dhabi Acre yield per crop	Crops per year	Total yield acre/year
Broccoli	4.2	13.0	3	39.0
Bush beans	3.0	4.6	4	18.4
Cabbage	12.0	23.0	3	69.0
Cucumber	12.0	70.0	3	210.0
Tomato	30.0	60.0	2	120.0

Higher yields, more frequent harvests, and better quality of the controlled-environment greenhouse-grown vegetables offsets the slight disadvantage of longer ripening time of some of the crops.

Growing and harvest periods: open fields versus controlled environment

Vegetable	Growing period (days) Field	Greenhouse	Harvest period (days) Field	Greenhouse
Cabbage	62±	51	1	1
Cucumber	90	83	55	30
Eggplant	130	181	40	125
Lettuce	70	38	10	4
Radish	30	30	1	4
Tomato	140	130	50	69

an evaporative cooler, but rather a direct-contact heat exchanger. Because the corrugated asbestos spread out the water, the effective heat-transfer area was high. Nominally, seawater flowed through the corrugated asbestos at a rate of about 120 gal./m., and the temperature of the air blown from the packed column remained near that of the incoming seawater. On hot days, the cooling flow could be increased to 140 gal./m. or so. This would bring the interiors closer to seawater temperature. If higher night temperatures were desired during the winter, the water flow could be shut off completely. On extremely cold days, 94°F. blowdown seawater from the desalting plant outlet could be piped into the houses for warmth.

Water Use Down, Crop Yields Up

Winter or summer, damp tropical conditions prevailed within the greenhouses, sheltered as they were from the harshness of the surrounding desert. Eighteen different kinds of vegetables, as well as strawberries, have been harvested from this manipulated environment. Once the plastic covers were in place and the greenhouses were inflated, the beach sand was leached to remove excess salt, a step that required no more than a half-gallon of pure water per square foot of growing area. When the experiments began, the vegetables were seeded in separate plots of either the natural beach sand or an amalgam of vermiculite and sphagnum peat moss. The crops did no better in the artificial medium; since the they have been set out only in the native sand.

Water-soluble fertilizers (mainly nitrogen, phosphorus, potassium, magnesium, calcium, and iron) were mixed with the desalted water for irrigation; this mixture then was rationed frugally to the crops through trickle (or drip) irrigation systems. One such system watered each plant individually from a spaghetti-like network of tiny plastic tubes; another released water in small droplets at soil level through perforated plastic tubing. Only enough water was applied, with each treatment, to reach the bottom of the root zone. As hundreds of horticultural varieties were tested, it quickly became evident that those plants that were developed in hot, humid areas would respond best to the closed environments.

Not only did this approach require one-third as much water, but because of the heat and intensive light, many crops matured more rapidly than they would have outdoors—bibb lettuce, for instance, was ready for the table 20 days sooner—and most of them produced far more profusely. Again to use lettuce as an example, the yields were five times those of open fields. The productivity of carrots, eggplant and radishes were more than doubled.

The closed-system houses proved to be hotter in mid-summer than was the ideal for tomatoes and some other varieties. Some of the laboratory's later models are compromises: they have fiberglass sides but plastic roofs, and the moistened air flows in one end and out the other.

Of course, people have nurtured vines in shelters of one sort or another for a long time. Tiberius Caesar, the emperor who ruled Rome for almost a third of the first Christian century, is said to have possessed such

an affinity for cucumbers that considerable trouble was taken to provide them for him. His minions tinkered together portable cucumber beds—covered with such fairly transparent stone as slate and mica—that could be carried indoors on chilly Italian days. George Washington protected citrus trees in a heated "orangery" at Mount Vernon. Even before then, a glass-sided conservatory, which contained exotic shrubs, had been built on the James Beckman estate in New York—which became distinguished as the place where Nathan Hale was detained the night before his appointment with a British hangman. Whether the Beckman building was heated, no one knows now.

The present greenhouse industry, which is not large compared with agriculture as a whole, has developed more in Europe than in this nation. At last accounting, there was slightly more than 1000 acres of vegetable greenhouses in the U.S., or less than the island of Guernsey alone has. Wherever they are located, most modern greenhouses usually are simple glass affairs with rudimentary environmental controls—usually only heating in order to extend growing seasons into the winter. What the Arizona group has contributed, then, are ways of much more precise manipulation of the microclimate and the use, where it can be done, of seawater for cooling greenhouses in the summer. These methods, more akin to industry than to traditional crop husbandry, appeared to make farming feasible in locations where otherwise it would be impractical, particularly on desert coasts.

Growing in the Abu Dhabi Desert

The experimental greenhouses at Puerto Penasco were about a year old when word of them reached Abu Dhabi, a small, oil-rich principality on the Persian Gulf 500 miles south of Kuwait. A government official there read about the Mexican work in *Time* magazine and discussed it with the ruler, Shaikh Zayed. The Shaikh decided that his desert country needed an integrated power-water-food facility. The only vegetables grown in Abu Dhabi (population ca. 50,000) at that time were produced seasonally, and in limited quantities, at an inland oasis called Al-Ain.

The ruler offered to finance some training and research in Arizona and Mexico as well as his new horticultural center. The site he selected for the center was Jazirat as Sadiyat (the Island of Happiness), across a narrow inlet from his capital. Sadiyat was essentially inhabited only by the families of fishermen who occupied 24 palm-frond huts, or "barrastis."

Because the island lacked both water and roads, the University's resident staff, which arrived early in 1970, first had to build a jetty, a construction-phase desalting plant, and almost two miles of paved roads. A research greenhouse had been planted by that June, and work began on the five acres of commercial greenhouses. When completed early in 1971, half of the spread consisted of 48 inflated half-bubbles of plastic, each approximately the same size as those at Puerto Penasco. While the Puerto Penasco structures must be entered through underground air-locks, those on Sadiyat branch off from central concrete tunnels that serve both as air-locks and as packing areas. Four steel-framed polyethylene-covered houses, totaling about 101,000 square feet, sprawl across the remaining 2½ acres.

The center was designed in this manner so that such low-growing crops as cabbage, spinach and beans, which need no supports, could be grown in the pneumatic houses, while tomatoes and cucumbers, which are trained vertically on a cordon system, might be planted in the structured houses.

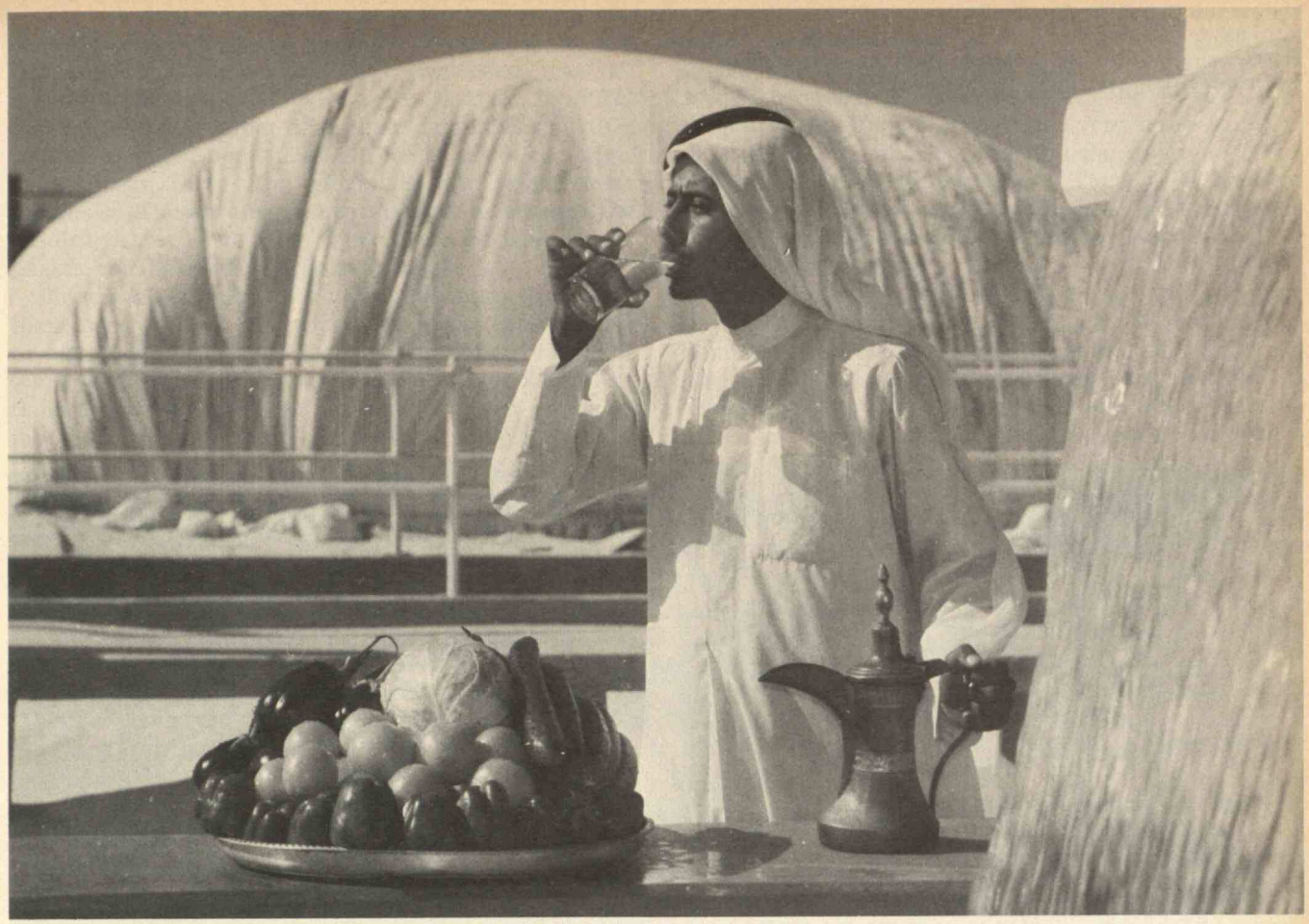
Three diesel engines, developing 580 B.H.P. at 750 r.p.m., provide power. A waste-heat recovery muffler connected to each engine provides energy for the desalting plant, a multiple-effect, spray-flash, 70,000-gal./day unit. This unit makes, primarily for irrigation purposes, a distillate with a purity of 0.5 to 1 p.p.m. dissolved solids. For cooling the greenhouses, untreated seawater is pumped directly from the Gulf by vertical turbine pumps, at temperatures that vary seasonally from 66° to 88°F.

Summer heat proved to be a major challenge. Inside the chambers, the average daily dry bulb temperatures reach a maximum of 93°F. in June, but the wet bulb temperature continues to rise until September, decreasing the effectiveness of the cooling system. For example, in June at the maximum day temperature a 42°F. suppression of the ambient temperatures can be attained but only a 35°F differential would be possible in August because of the higher relative humidity. In the summer, night temperature in the greenhouses will reach a low of only 86°F. It is these high night temperatures that accelerate high rates of respiration in the plant, making it difficult to achieve good yields of most crops except for Malabar spinach, melons, and cucumbers. As at Puerto Penasco, in the summer the greenhouses are shaded at varying extents, depending on the crop. These decreases the amount of incoming radiation and therefore the heat load within the greenhouse.

Growing temperatures of 75°F. by day and 64°F. by night can be maintained during the winter by regulating the evaporative cooling system and/or the amount of incoming air. The evaporative cooling system used in Abu Dhabi are corrugated-asbestos heat exchangers. Seawater is sprayed over the top of these corrugated materials. Wintertime heating systems are not necessary (the lowest recorded temperature on the Abu Dhabi coastline was 50°F.).

In the framed greenhouses, air is exhausted through the middle of the roof. The negative pressure that this creates inside results in air flow into the house across the heat exchanger. In the inflated greenhouses, air is pulled through the asbestos by fans mounted in the end wall. The air that is forced through the house is exhausted through the roof of the central corridor to which the air-supported greenhouses are attached. The corrugated materials provide a large surface area for contact between seawater and air. Humidity within the houses normally is high, because the cooling system, which operates nearly all year, essentially saturates the already-humid incoming air with moisture.

The horticultural techniques developed at Puerto Penasco needed little modification. Once more, the vegetables were sown directly in the indigenous beach sand (which on Sadiyat is more than 95 per cent calcium carbonate with a pH of 8.3); commercial-grade, water-soluble fertilizers were added to the irrigation water, and this mixture then was applied through trickle irrigation systems. Again, the varieties that had originated in tropical regions turned out to be the most suited for the rain-forest conditions of the green-



Cucumber, cabbage, peppers, tomatoes, and eggplant—water-rich vegetables piled like jewels from the Arabian Nights—grow in the controlled-environment food factories in the sea-side desert of Abu Dhabi. (Photo: Manley, Tucson)

houses; the tomato that has grown best on the island is one bred at the University of Hawaii. Lettuce for reasons still not understood has grown poorly, but most other crops have succeeded. Even under the constraints of summer heat, it has been possible to produce two yearly crops of tomatoes, for example.

Covering the World with Cucumbers

As a result, the productivity of Puerto Penasco has been more than duplicated in Abu Dhabi. Last year for instance, four times as many tomatoes were carted from the Sadiyat greenhouses as one would pick from open fields in the United States, in part because two full crops a year could be harvested from the greenhouses. Yields of cabbage were five times what they would have been in a productive field. Crops usually matured more rapidly in the enclosures, and harvest periods by and large lasted longer. Altogether, the five acres of covered beach sand gave up an average of a ton a day of high-quality vegetables, and the year-long output of tomatoes alone was enough to supply almost 10,000 persons at U.S. levels of consumption.

The most impressive results came with cucumbers, which seldom bear more than a dozen tons/acre/crop in American fields. More than five times that much, or 60 tons/acre/crop, has been taken from the Sadiyat structures; by growing continuously it becomes possible to obtain 210 tons/acre each 12 months. (Extrapolation can be exhilarating. Assume a global population of six billion in the year 2000. In the improbable event that only one per cent of our planet's 2.5 million square miles of coastal deserts was covered by then with such greenhouses and planted entirely in cucumbers, enough of the green cucurbits would pour from them to allot every human on earth three pounds a day.)

Actually, what vegetables are sown depends considerably upon the market. Fifteen different Sadiyat crops have been sold locally, including eggplant, peppers, radishes, turnips, parsley, spinach, broccoli, cabbage, snap beans, squash, kale, and beets. But each was evaluated for marketability as well as productivity, and the results suggest that tomatoes and cucumbers would be the most profitable.

Harvesting also has been timed so that the greenhouse produce does not compete with the fairly limited supply that comes from the Al-Ain oasis. This desire to avoid local competition was the point of the trial shipments to Lebanon, where the prices commanded were sufficient to make such exports realistic, once the local market is satisfied. Exporting could be especially attractive, since demand is high in Beirut at a time (from mid-November through mid-March) when sales from Al-Ain reach their nadir.

From the beginning of the project, the goal was to

Tomatoes cultivated in the Abu Dhabi "greenhouses" thrive on the fertilizer-treated desert sand. Developed especially for tropical climates at the University of Hawaii, these tomatoes produce two harvests per year. (Photo: Manley, Tucson)

invest full management, ultimately, in the local people. Because of this, training has been stressed. How well this transfer of technology has succeeded may be measured by the fact that all the trainees have remained in the program after their apprenticeships. Or its success might be evinced in the careers of the original trainees, three Abu Dhabians who spent seven months in Tucson and Puerto Penasco to acquire the requisite skills. Two now manage the Sadiyat greenhouses; the third is in charge of packing.

But the new facility has meant far more to Sadiyat than merely a few jobs. Once the island families had to haul water from the mainland, but now they get water and electricity from the new facility. Several of them boast television sets, and Shaikh Zayed is replacing their old huts with modern houses. Where once there was only saltbush, now trees and grass are irrigated with effluent from a sewage treatment unit at the facility.

The Technology Exists—Refinements Needed

The Abu Dhabi installation, the first large scale desert "vegetable factory," undoubtedly is the first of many. Across the Gulf, the area's oil companies asked E.R.L. engineers to design two acres of controlled-environment greenhouses for the Iranian island of Kharg, the largest petroleum depot in the world. The first crops there will be harvested this year.

Back in the United States, the first purely commercial application of this technology already was in business. Environmental Farms, Inc. (E.F.I.), near the laboratory on the fringe of Tucson, broke ground in 1968 for a modest 1.2 acre facility. Three years later, Superior Farming Co., a large California-based agrobusiness concern, purchased the property and set out on a $1.5 million program to expand E.F.I. to 10 acres. When that construction was completed at the end of 1972, there were five new fiberglass-and-plastic greenhouses. Two of them were 264 by 541 feet—or thrice the size of a football field. These rigid-framed structures were designed by E.R.L. engineers. They are built of galvanized steel columns, bar joists and gutters, fiberglass walls, and inflated "pillow" roofs, each roof made up of two polyethylene sheets separated by air. The air layer facilitates temperature control inside the house; and the plastic covers, like those at Puerto Penasco, can be coated at the onset of summer to reduce the heat load, and then changed with autumn's arrival. Horizontal aspin pads and centrally-located exhaust fans evaporatively cool the growing area, which is heated by conventional fan-coil units that are supplied hot water from two central heating stations. Municipal water is abundant. In 1973, its first full year of operation, Environmental Farms marketed almost 1,150 tons of tomatoes, its only product (again, by contrast, a grower would consider 150 tons a fortunate yield from an outdoor plot of that size). Still, the laboratory horticulturists suspect that even this volume can be multiplied by introducing new varieties and by more sophisticated environmental engineering. As one small, straightforward example of what might be done, it was found that tomato quality tended to improve when the upper leaves were pruned in such a way that they provided shade for the fruits below.

As is true at Abu Dhabi, the Tucson tomatoes, most of which are of prime quality and sell on supermarket shelves in the Midwest and Northeast, are planted directly in desert sand that has been washed and screened. The same growing medium is utilized at a second commercial installation designed by ERL—on the Fort Yuma Indian Reservation. The reservation lies in a part of eastern California, on the Colorado River, where such sand is not scarce. There, five acres of growing enclosures were established last year with federal funds; the project has assured employment for 20 to 30 tribesmen.

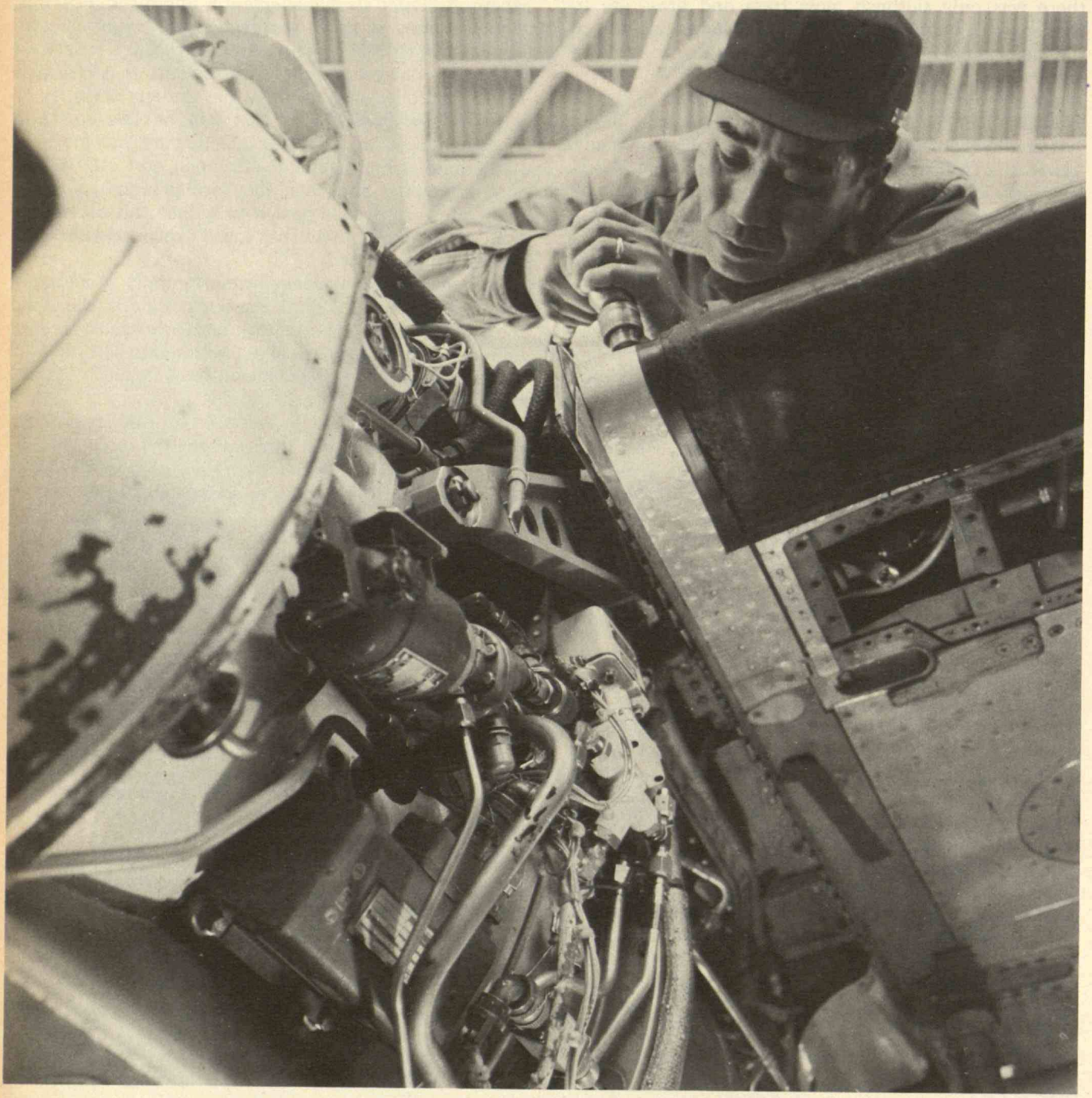
Technologically, controlled-environment agriculture seems, to us, to need only refinement. As for the economics, more experience will be instructive. Neither the Abu Dhabi project, because of its logistics, nor the Fort Yuma complex, which was federally funded, bears much resemblance to any future investments—anywhere. Although its management is optimistic, Environmental Farms is new. Meanwhile, the research continues. Among other things, a plant breeder is seeking to winnow out genetically those varieties that fare best under controlled conditions, while the engineers try to develop new greenhouses that will be less costly to erect and operate. The present ones are not inexpensive (those at Fort Yuma, for instance, cost $120,000 an acre to build), and thus they are practical only for high-value crops. One goal is to reduce this capitalization so that high-protein but lower cost foodstuffs may be similarly produced.

Last year, the laboratory began to apply to aquaculture (the husbandry of marine life) some of the same techniques it has devised for horticulture. As a preliminary step, shrimp are being cultured experimentally in the air-inflated greenhouses—now called "Aquacells"—at Puerto Penasco.

Shrimp are unlikely to stave off a famine, nor are tomatoes. But what one learns about the intensive, engineered cultivation of them—or any other food—nonetheless could have a considerable impact.

Carl N. Hodges has directed the Environmental Research Laboratory (formerly the Solar Energy Laboratory) at the University of Arizona since 1963. His bachelor's degree, from the same university, is in mathematics. Mr. Hodges has published widely on heat transfer, solar-energy utilization, desalination, and intensive agriculture.

Japanese industry is caught in a frustrating circle—imported technology encourages a frozen industrial bureaucracy, which kills creativity, in turn creating the need for more imported technology.



Japanese worker assembles a turboprop transport plane at Mitsubishi Heavy Industries, Ltd. Such manufacturing giants as Mitsubishi have revolutionized Japanese industry using imported technology, but at the expense of encouraging creativity among their own workers. (Photo courtesy of Consulate General of Japan, New York)

Kenichi Ohmae
McKinsey and Co., Inc.

Yokkakari: The Cycle of Dependence in the Japanese Corporation

Japan has achieved remarkable economic success in the past two decades. A number of favorable factors are responsible, ranging from the loyalty and high productivity of Japanese workers to the close cooperation between government and industry. Recently, however, people have begun to pay more attention to the negative side of Japan's enormous drive for success. Japan's social welfare program, for example, is far behind those of most Western nations. Some young workers have left the assembly lines because they do not feel like working on sunny days—even when the sun is obscured behind the smog of Honshu skies. In a word, Japan seems to be following the path that the most advanced nations have trodden before: lower production for higher wages, strained industrial relations, more material goods but less of life's amenities.

Yet I believe Japan's experience is fundamentally different from the West's, different in ways that have been largely unobserved by Japan watchers. I believe that there exists in Japan a unique self-perpetuating cycle based on "dependence," or *Yokkakari*. In this article I will discuss how the Yokkakari Cycle applies to Japan's unique dependence on other nations for technological innovation. For my purposes the basic cycle consists of three segments, each one helping to maintain the other—dependence on imported technology; inflexible industrial heirarchy and guaranteed promotions; and lost creativity and self-motivation. Japan's technological dependence on other nations, for example, has developed because Japan was a late starter; in the absence of domestic technical know-how in the 1950s and early 1960s, Japanese corporations were forced to depend on imported technology. This was favorable to most corporations, because they could catch up with the Western nations without the risk of failure in their research and development efforts. In a production-oriented society—that of Japan in past decades—the Yokkakari cycle was the key factor for success. But the cycle cannot operate successfully today, since the cycle has created amiable but stagnant and inflexible relationships between workers and employers, between government and industry, and moreover, between Japan and the rest of the world. I believe that the Yokkakari cycle must be broken if Japan is to maintain its leading economic position. For in tomorrow's competitive world, creativity, innovation, and imagination will rank equal to labor productivity as keys to economic success.

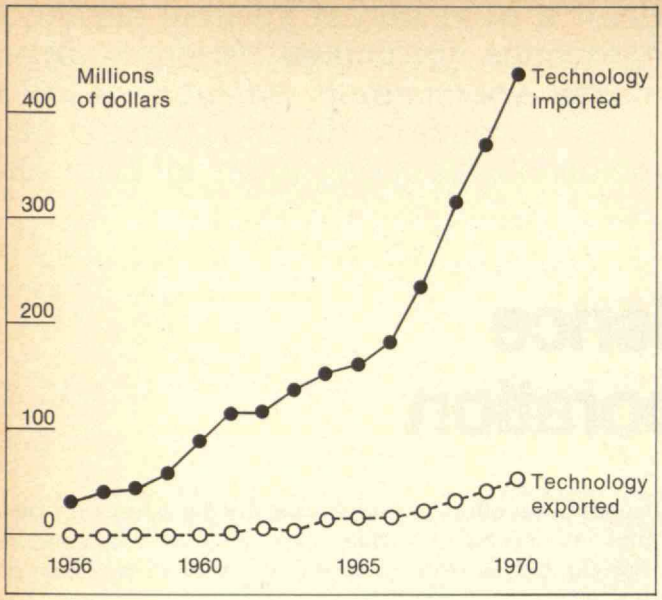
In this article, I will try to trace the origin of Yokkakari in an effort to understand the problems that this thus-far successful nation must solve in the coming decade. Let us begin with the way a child is reared in Japan.

Educating for Yokkakari

Every Monday morning, I can hear the loudspeaker from a nearby elementary schoolyard, hear the schoolmaster saying "Mae-e Narae!" Without being there, I can picture the scene, for it has not changed since I went to school 25 years ago. The pupils are being told to line up straight. Those who fail to do so, will be given a slap, or at least made to stand outside the classroom for ten minutes.

The scene is a typical one. Students find it extremely difficult to deviate from the norm, or do anything that others don't do. By the time of graduation to junior high school, a "Don't be conspicuous" concept has so deeply penetrated a student's daily life that he cannot even conceive of dropping out of the long and severe race to the college entrance examination. In high school, students are continually informed that if they sleep more than five hours a day, they will not make it to a first-class university, and hence will not make it to the top of the hierarchy that follows. Since most universities still select students by means of multiple choice tests, students have to pack their brains with facts and figures. Thus, students must remember things without reasoning them out, and may not stop for a moment to *think*. A successful student will have memorized over 3,000 English words, dates of important historical events, names of the 107 elements in the periodic table, and the basic equations and conversion factors of physics and mathematics.

When he makes it to a university (some 20 to 30 per cent of high school graduates, called "Ronin," spend extra years studying to get in), the student finds that all the information he has stored for years is impractical and useless. His detailed knowledge of dates and events in the Russian Revolution is inadequate to explain why the Japanese Socialist Party is pro-Russian but anti-Chinese, and why the Japanese Communist Party is anti-Chinese and anti-Russian whereas it was pro-Chinese but anti-Russian five years ago. Consequently, he finds escape in the digest edition of Karl Marx's *Das Kapital*, frequents a local bar, and plays mahjongg day and night. For physical stimulation, he joins one of the divided sects of Zengakuren (the radical student movement), and marches down the major streets to a stone-



The imbalance in Japan's foreign technological trade from 1956 to 1970: Although the ratio is improving, in 1970 Japan still imported over seven times as much technology as it exported.

throwing game with the riot police. In the end, he shakes off every bit of knowledge he had carried into college with him, and graduates completely "bleached," ready to start his career. His university professors have acted as nothing less than the catalysts for the bleaching process.

The Making of an Engineer

Nowhere else in the world are there companies that employ as many new university graduates a year as do some of the largest Japanese corporations. For instance, in 1971 alone one of the top-ranking companies in Tokyo hired more than 1,000 graduates with B.S., M.S., and Ph.D. degrees. Even after the economic slowdown, this company hired another 650 graduates in 1972.

Let us take a look at the engineers who are responsible for maintaining a high standard of technology. One seemingly unimportant but actually crucial difference between Japanese and Western engineers seems to lie in their daily life outside the office. At a major manufacturing company in the outskirts of Tokyo, new engineers are assigned to one of four bachelors' dormitories located immediately outside the plant. Before he finds his wife (or some elderly person arranges a marriage), a typical young man will spend about five years in the dormitory, where his private life is severely restricted.

A popular Japanese axiom says: Don't be a nail sticking up from the floor—that's the one that gets hammered down! Most young men submit to the restrictions because, after all, these dormitories provide room and board, and they do not have to worry about "domestic" troubles. They can devote all of their time to the company.

A typical university graduate is not expected to know anything about a specialized field when he enters the company. It is commonly understood that it is the company, and not the university, that provides the specific working knowledge needed in today's industry. In Japan, university-industry cooperation is largely taboo, because a majority of Japanese intellectuals have not recovered from the nightmare of total defeat in the Second World War which, according to them, was brought on largely by an uncontrolled academic-industrial complex. As a result, a Japanese company's training program includes, in addition to the history of the company, such basics as drafting, accounting, computer programming, stress analysis, quality control, industrial management, materials science, and English conversation. By the end of his first year, the new employee will be made into a spotless "company man."

Dependence, Yokkakari, prevails in every aspect of an employee's lifetime devotion to the company. Promotion, for example, highly resembles that in the military. For a graduate of a prominent national university—a West Point, if you will—promotion is fastest and steadiest. There are few exceptions to age as the standard for promotion in the corporate hierarchy. An engineer will be identified by the year of his graduation, and few '64s will be promoted over '63s, regardless of their performance. It is true that some of the largest corporations have experimentally appointed outstanding young persons to a few key positions; but in many of these cases, psychological warfare has broken out, because older people have not yet learned to be directed by their juniors without feeling humiliation.

Since the new man does not have to worry about his promotion (governed as it is by an equation in which his age and the name of the university he attended are the key variables), it is not surprising that an engineer

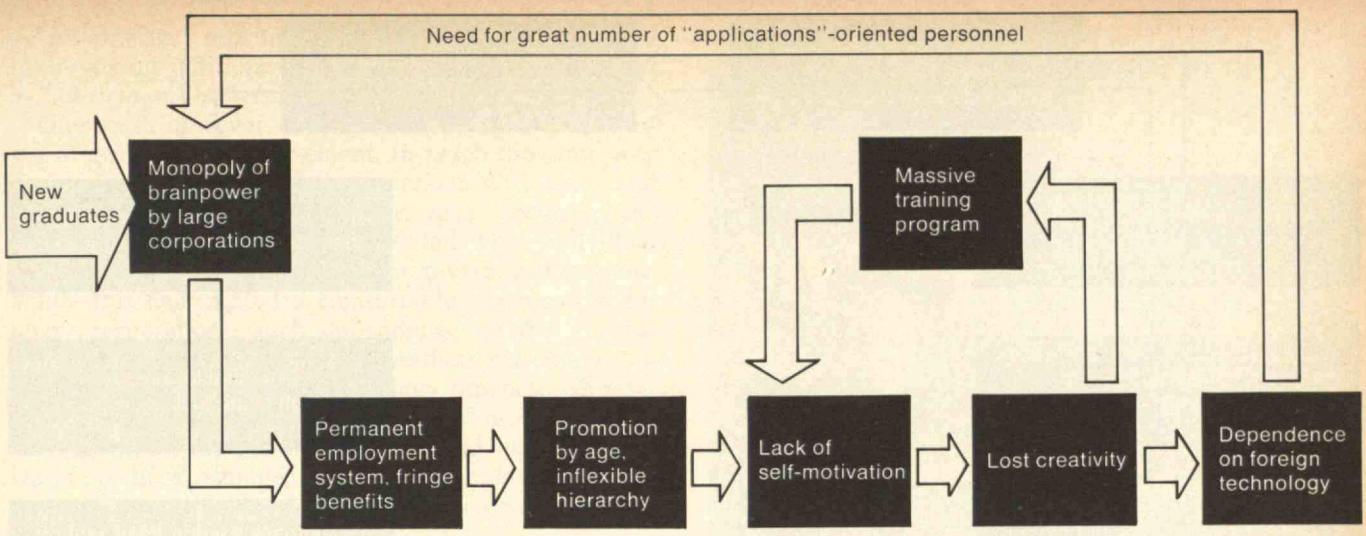
TO THE VISITORS

1. No one other than the parents and relatives of the dormitory residents are permitted inside.
2. Other visitors must register with the receptionist, and must obtain an entrance permit.
3. No visitors are allowed to stay past 10 p.m.

TO THE RESIDENTS

1. All electric appliances used in the occupant's room must be registered with the House Committee.
2. Electric capacity must not exceed 700 watts per room.
3. Electric heaters, if any, must not exceed 300 watts.
4. No electric heaters are allowed after March 31. There is no central heating.
5. Do not use the heaters before going to work.
6. No extension cords are allowed.
7. Ash trays must be larger than 10 cm. in diameter, and be filled with water.
8. Smoking while walking not permitted.
9. The Committee will investigate each room twice a day to make sure that above rules are not violated.

Rules and restrictions are posted at the entrance of the bachelor dormitory, provided by the company, where the young engineer spends the first years of his career. Such restrictions help to mold the engineer into a "company man."



A closer look at the general cycle shows how a Japanese worker enters industry's intellectual mill.

or a scientist should not be very creative. He has been trained to obey strict company rules and regulations in exchange for lifelong security, and has been taught to absorb things without reorganizing them to create new ideas. He is not allowed to raise questions about adversities besetting his company, nor to think spontaneously or creatively about them. He does not think about where a new technological breakthrough may lie, or about problems for which his creativity might provide a solution.

This rigid system of promotion creates a tremendous inertia and lack of self-motivation in the new employee of a big, stable corporation. There is practically no incentive for him to improve himself after hours, nor is there incentive for him to improve his abilities on the job, where the company's routine work keeps him at his limit of physical endurance, with overtime typically 60 hours a month, or three hours per working day.

Of course, management has not been without countermeasures to this inertia. They send some of their promising workers to training schools, invite lecturers and experts from the academic and scientific communities, and dispatch employees whenever there is an international conference on new and advanced concepts in science and technology. Unfortunately, those who participate in these training efforts tend to be preoccupied with accumulating facts; they pay relatively little attention to the development of concepts or to the implications of the information to which they are exposed.

A Stereotyped Image and the Yokkakari Cycle

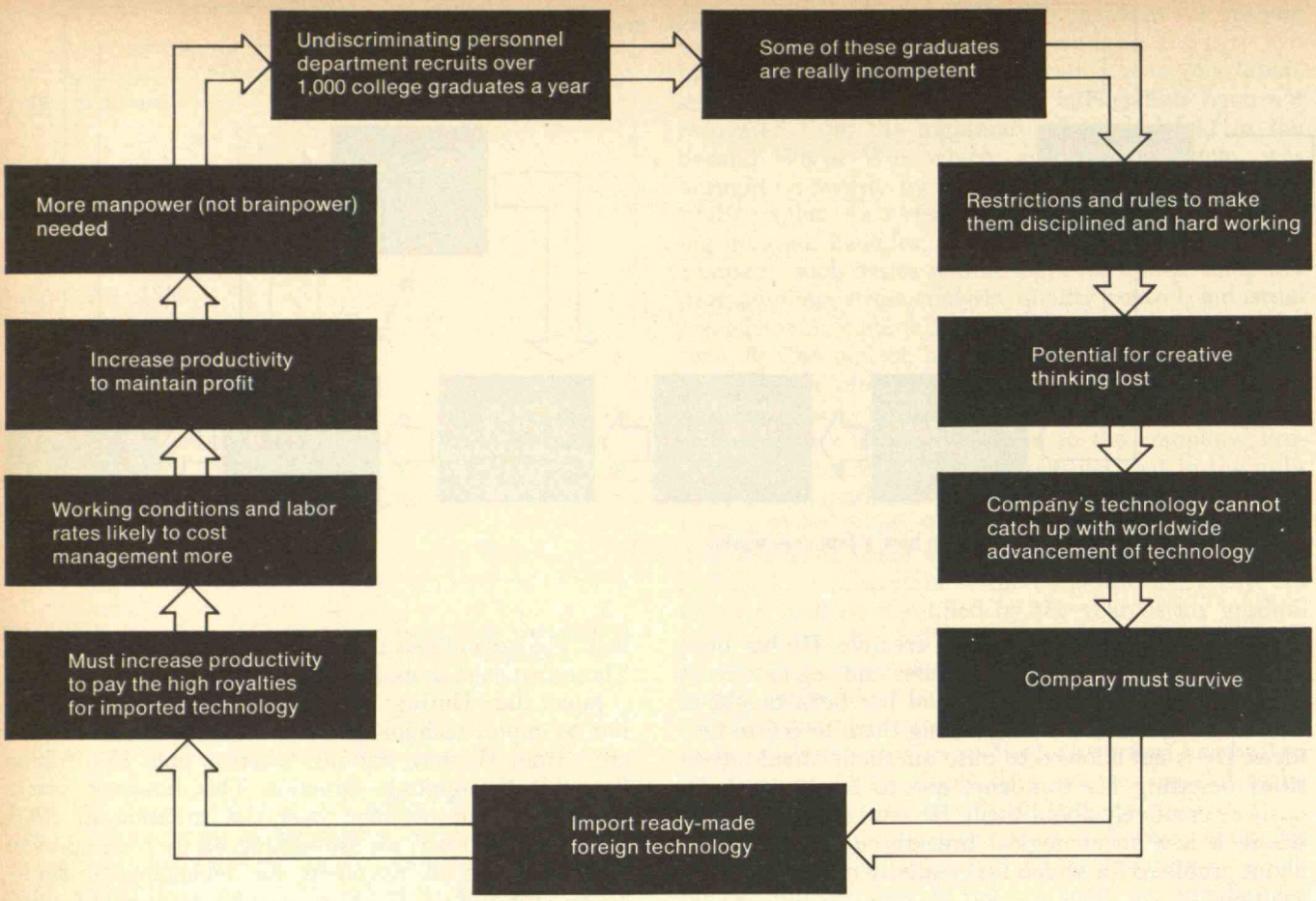
Said John Kenneth Galbraith once to an Indian audience: "Where imitation is appropriate, it should be unashamed. This will not be applauded by the more advanced countries; they have often felt that such behavior by the newcomer is not quite sporting. The British in the last century spoke more disrespectfully of the imitative tendencies of the Germans; no sooner did Sheffield have something that was good than Solingen had the same thing in a cheaper model. More recently the Japanese and the Soviets have been similarly criticized. Those who come later should be undeterred by such complaints. They should take unblushing advantage of the paths that were broken by those who went first. The advantages of the late arrival are all too few. Those that exist should be exploited."

Japan did: During 1970, Japan paid some $433 million to import technology (know-how, patents, licenses, etc.) from Western nations, whereas only $59 million flowed in the opposite direction. This, however, was a remarkable improvement over the situation in 1960, when the ratio was an astonishing 42 to 1. In spite of the imbalance of payments for technological trade, Japan still had an $8 billion surplus in overall foreign trade during 1971.

A late-starting nation must be able to absorb knowledge from the external world as quickly as possible to gain momentum in the market where needs are being expressed. Hence, the nation needs engineers and scientists who specialize and excel in development and application of new technology. Since they do not conduct basic research and development, their tasks are short-lived. A scientist who works for one of the largest printing companies in Japan told me that his company's research and development program is extremely short-lived and demanding of results: His average engagement on a given project lasts for only three to four weeks!

In most of Japan's large and stable corporations, engineers are so tuned to ready-made technology that they have a hard time creating new ideas or contributing to any long-term basic development programs. As a means of maintaining a constant supply of advanced technology, many Japanese corporations have come to have close relationships with foreign giants: Toshiba Group and Hitachi Group with General Electric Co. (U.S.A.); Fuji Electric Co. with Siemens (W. Germany); Mitsubishi Electric with Westinghouse (U.S.A.); Asahi Glass with Corning Glass (U.S.A.).

The result in prosperous Japanese corporations is the absence of "identity," by which I mean the unique technology or industrial know-how that results in marketable goods. A light water reactor may be constructed by Toshiba or Mitsubishi, and the reactor's huge outer containment building may be decorated with the familiar company insignia—but few people realize that the blueprints to build it came from G.E. or Westinghouse.



Industry's restrictive work cycle "blue-collarizes" educated Japanese workers.

Top management frequently advances one or more of three reasons for introducing foreign technology into its production line:
—A need to beat domestic competitors.
—A need to block the domination of the domestic market by foreign business.
—A need to supplement the lack of creativity and competence of a company's own engineers and scientists.

This is the Yokkakari Cycle that prevails over Japan. The results are the same regardless of where in the cycle one starts.

Productivity, Not Creativity, Thus Far

Against this background of dependency and lack of self-motivation on the part of Japanese workers, and of corporations not developing basic domestic technology, the reader may wonder how Japan could have achieved its continued post-war economic development. This seeming paradox can be resolved by recognizing that productivity, and not creativity, has accounted for Japan's success.

The ingredients of this productivity-based success have been:

First, Japan's history of subordination of the individual. The history and structure of Japanese society has allowed industry to take greater advantage of American productivity methods than has the U.S. itself. Large-scale, modern industry, Galbraith points out, requires a solid hierarchy and complete subordination to the corporation. Thus, conventional management theories aimed at increasing productivity assume the commitment of a worker to his work, and assume the need for a high degree of discipline and supervision. The Japanese had experienced complete subordination to the Tokugawa Shogunate for 250 years by the time Commodore Perry came to Yokosuka in 1853. Between 1868, the start of the Meiji Restoration, and 1945, the end of World War II, they had another experience of complete devotion, this time to the reigning Emperor. Today, the corporation has largely taken the place of Emperor or Shogun as the object of loyalty, and the Japanese have provided solid proof of the workability of conventional management theories.

Second, the role of the government in Japan, as in all modern technological societies, has been critical to its industrial success. Government involvement in the economy has been extensive and successful, when measured in terms of the GNP curve. As examples:
—A closely knit government-banking-industry relationship has supported highly leveraged capital structures.
—Recognition by the Ministry of International Trade and Industry of the importance of economies of scale resulted in guidelines that required new industrial facilities to meet minimum size levels that would be considered gargantuan in other countries.
—The government permitted commercial banks to "overloan" and thus encouraged a high level of capital expenditure: over 30 per cent of the GNP in Japan, compared to about one-third that amount in Western nations.

—"Amakudari," retiring government officials, accepted high-ranking positions in large corporations, and acted as "lubrication" between industry and government.

One must, however, keep in mind the potential danger of government involvement. In much the same way as corporations surround their workers with rules and restrictions in exchange for workers' security, the government has spelled out in detail what individual industries may do, in exchange for government support. While this has created a comfortable environment for many corporations, such dependence on the government has also made these corporations extremely vulnerable to change. As a result, many Japanese corporations have been reluctant to make bold moves in areas such as direct investment overseas and multinationalization of their management, by and large still remaining in the export-oriented stage of corporate development.

The third factor in Japan's economic success has been the import of technology on the same basis as it has imported such natural resources as iron ore, petroleum, and coal. The importation of technical know-how has been taken for granted and has become an important phase in the Yokkakari Cycle.

Japan's Need for Change

Although dependence on imported technology has worked so far, a number of pressures are building to make it imperative that the Cycle be broken.

First is the intrinsic need for industrial nations to eventually develop home-grown creativity, and Japan has not done this; next are external pressures for change; and finally, domestic forces are at work.

—As long as one considers relatively mature industrial technologies, productivity may be the key to success. Up until now, the ability to mass-produce has been one of the major advantages for most industries. But what about the future? As an industrial nation matures, it shifts toward soft science and service industries, which do not rely on efficiency of production as much as they do on efficiency of creative thinking. In these new industries, value is added to the final product by brainpower creativity, rather than productivity. Since creativity itself cannot be imported, it must be developed in the land where it is to be used. If the Yokkakari Cycle has contributed to increasing productivity at the expense of creativity, it is time to break the Cycle so that Japan may continue to be successful.

—A growing concern in Japan is that advanced Western countries will become more reluctant to sell technical know-how to the Japanese, since the long-term return is likely to be the stiffest competition of any industrial nation. Western industrial nations are suffering: The Japanese textile, steel, and electronics industries hurt the Americans; the Japanese watch industry hurt the Swiss; its camera and automobile industries hurt the Germans; and its color TV, shipbuilding, and electron-optics industries hurt the British.

—Owing to its voracious appetite, Japan has already exhausted a good portion of the so-called advanced technology in the West, and has digested it to the extent the West did. Hence, even if the Western nations remain as generous as before in sharing their technology with the Japanese, their saleable resources will not be as abundant or as attractive as before. Moreover, world-wide resources of new technological breakthroughs have become leaner lately. Thus, there is little room for optimism that the flow of technology will continue in the same amount and with the same ease.

A Kacho—a section manager—merits a desk by a window facing his section's employees. Promotion to a Kacho position comes to the employee through time spent with the company and age, rather than as a reward or recognition for a job well performed. This results in more section managers with each year of the company's existence, and a proportionately increased payroll with company age.

In addition to these external factors, domestic pressures are building to break the Cycle:

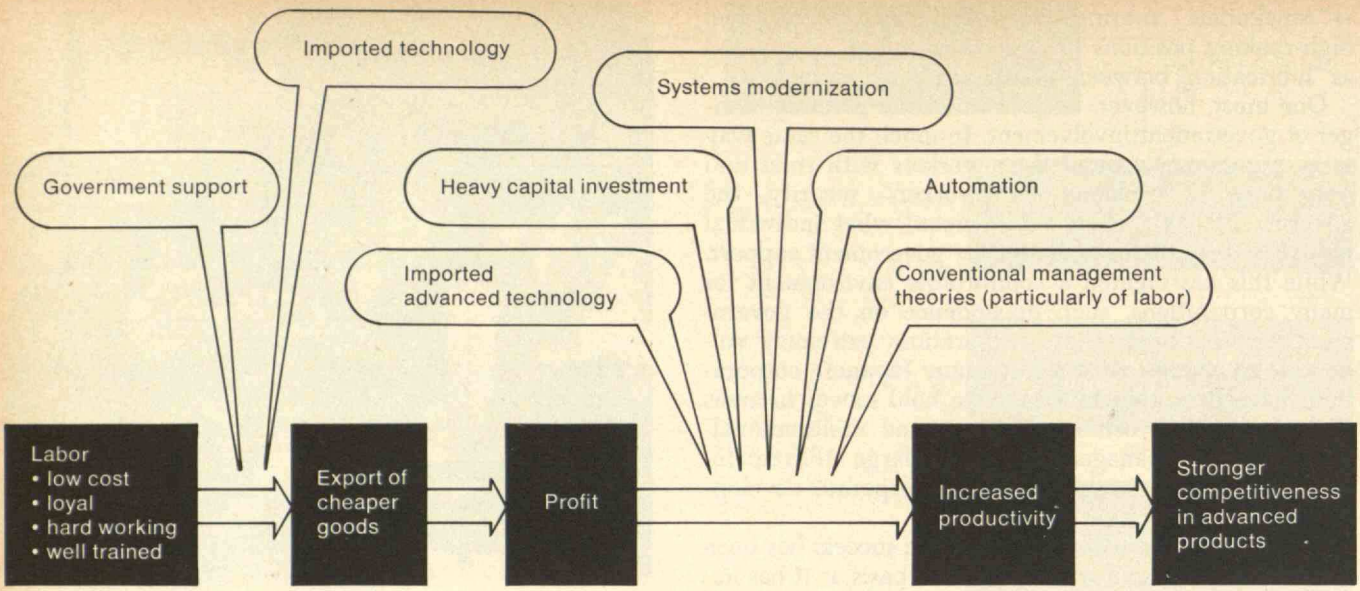
—The yen revaluations of 1971 and 1973 have weakened the relative competitiveness of Japanese goods in the foreign market, as well as in the domestic market, although the hard-working Japanese seem to have made up for the loss to some extent already.

—As the result of a decade-long booming economy, Japanese industry has been turned up to "stretch" capacity operation. Thus it is now vulnerable to external disturbances, such as world-wide depression, or even the slightest sign of economic slowdown.

—Labor cost has been escalating at an annual rate of 15, and lately 30 per cent. This trend has made production by "cheap Japanese labor" a hollow phrase, since such labor is no longer available. In fact, some Japanese companies, notably in labor-intensive industries, have lost their profitability, and their outlook is quite gloomy. For they can no longer afford heavy capital investment, which is nothing but the past successful pattern of "overloan."

Pressures for change have led to a variety of conclusions. Some pessimists argue that there is no hope that the Japanese will change their traditional approach and that it is impossible to break the Cycle. Instead, they have high expectations for the Japan-China relationship, hoping that Japan can sell a considerable amount of industrial output to China without the necessity of greatly improving the current technological position.

On the other hand, optimists argue that Japanese inventiveness is not in science and technology, but in the overall performance and policies of its well-coordinated government-industry system. Hence, no matter where inventions originate, the Japanese would be the



The Post-war Japanese Economy (1945-1972)

In the past, the success of Japanese industry has depended on the Japanese worker, government support, and imported technology.

first to capitalize on the opportunities. It is quite easy to support this opinion with recent examples as petrochemical refineries, steelmaking, the Wankel engine, integrated circuitry, and even point filaments in the scanning electron microscope.

There are still others whom I would call opportunists, whose argument relies heavily on prevailing circumstances. They argue that the lack of creativity of the Japanese can be attributed to the fact that there had been very little need for it in the past, or the fact that Japan had to quickly organize its economy from the ashes of the last world war. This, according to the opportunists, dictated short-term research and development expenditures, which, more often than not, were based on the purchase of external technology. These people, therefore, believe that the Japanese would easily become "creative," when such need arises.

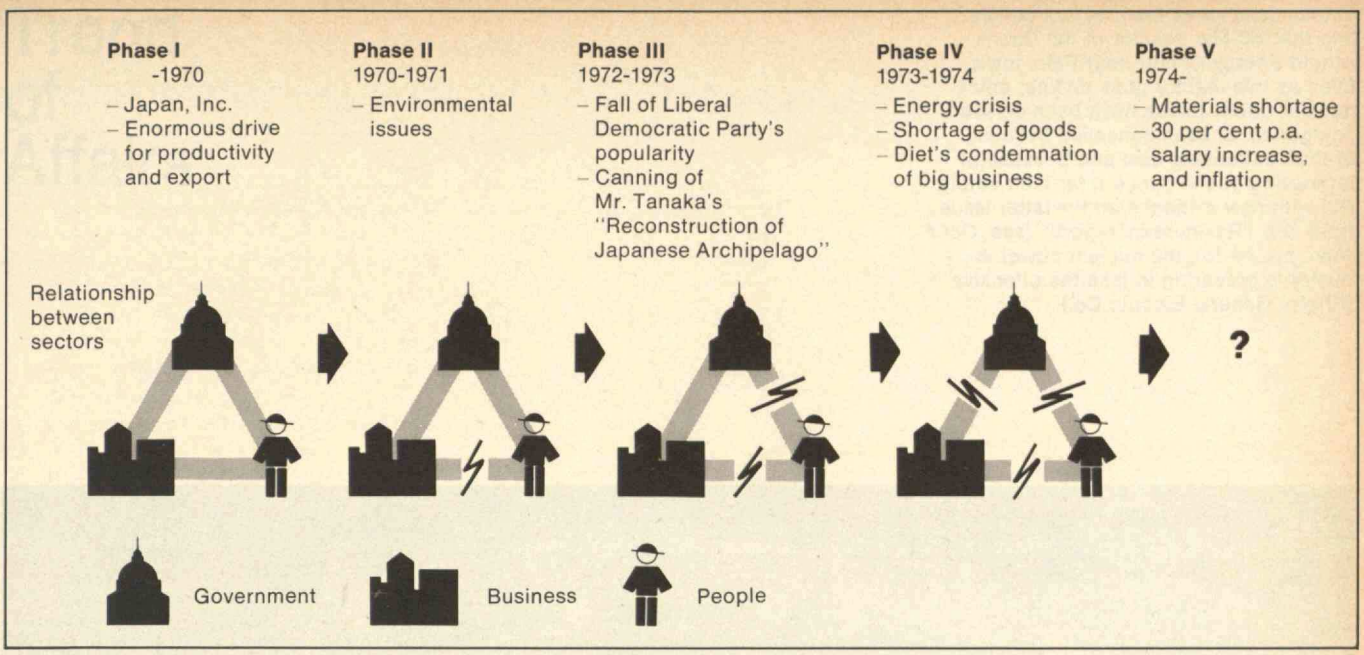
Exits from the Cycle

Having discussed the origin of Yokkakari, we might now be able to discuss some possible exits from the Cycle. We know that the fundamental cure lies in the way children are brought up, and also in the educational system. In this regard, the current trend in Japanese society makes one pessimistic, because affluence is allowing parents to spend more time and money spoiling their children.

However, one encouraging sign, beyond the early education, is that more and more business leaders in Japan are recognizing the importance of modifying traditional approaches. For example, from the more liberal laboratories have come such new ideas as single-gun color television, which is apparently superior to the existing three-gun color matching technique, and the CVCC (compound vortex controlled combustion) engine, said to be compatible with even America's strict 1976 pollution standards. Likewise, long term research and development has made a small Hiroshima auto manufacturer into the world market's leader in Wankel-engine cars. It is also true that an increasing amount of Japanese trading companies' business has something to do with exchanging technical know-how between their Japanese and American clients. It appears possible that such successful examples as these will stimulate other corporations to take this positive approach. However, of the various and many constituents of the Yokkakari Cycle, discoveries of the right exits for two particular problems appear most imperative, i.e., seniority-based promotion, and government-industry coalition:

—*Promotion by age:* It seems every young Japanese is against this tradition, and I am sure this was also the case 50 years ago. Let us compare promotion by performance and promotion by age. A capable young American will often become a manager. When a different need arises, the young man will not want to step down from his position, but there is no guarantee that he will be as good in this new situation. Promotion is emotionally an irreversible process. Thus, while promotion by performance tends to favor high performance, it also tends to be unstable and difficult to manage in the long run. Most Japanese corporations have made it a rule to wait at least for ten years after employing a college graduate before giving him a responsible position with a title. This system has enabled corporations to give everyone a fair chance to exhibit his capabilities, and the selection of an elite group after a long incubation period has proved to be highly successful. But today this system is up against a wall.

Some 15 years ago most Japanese companies, in the upswing of the national economy, recruited hundreds of college graduates a year. Today, hundreds among them are up for evaluation for a Kacho (section manager) position. It is impossible to generate a few hundred new "sections" every year. Hence, they cannot all be promoted. A Kacho would use a larger desk and take up more space in the office than a non-titled worker. He would sit against the window, facing his



The history of Japan's industrial economy shows broad and rapid changes in the current decade; together they represent what the author calls "a drastic change in the underlying assumption of the Yokkakari Cycle."

section's employees. I have seen in recent years offices with so many Kachos already sitting against the window that it would be physically impossible to squeeze in another desk.

Promotion by age has meant an increased payroll with corporate age. Against a constantly increasing number of employees, Japanese executives must also cope with constantly increasing salary per head, arising from the promotion itself, apart from inflation. Very soon, Japanese corporations will be forced to evaluate an individual on his performance and on his net incremental contribution to the company against his salary and the company's overall available positions.

—*Government-industry coalition:* The world famous cooperation between government and industry in Japan has been identified as "Japan, Inc." by envious observers. In my opinion, Japan, Inc., had a third harmonious component: people. For people in Japan used to be permissive to the government's favoritism to industry because they thought, reluctantly, that the benefit would eventually return to the public. However, a recent survey by Sanwa Bank shows that Japan has the lowest "happiness index" among the industrialized nations, as calculated from such indicators as wages, consumer goods consumption rates, rooms per person, and expenditures on welfare programs. On the contrary, it has by far the highest "irritation index," as calculated from such negative factors as consumer price index, pollution, population density, and traffic and subway congestion.

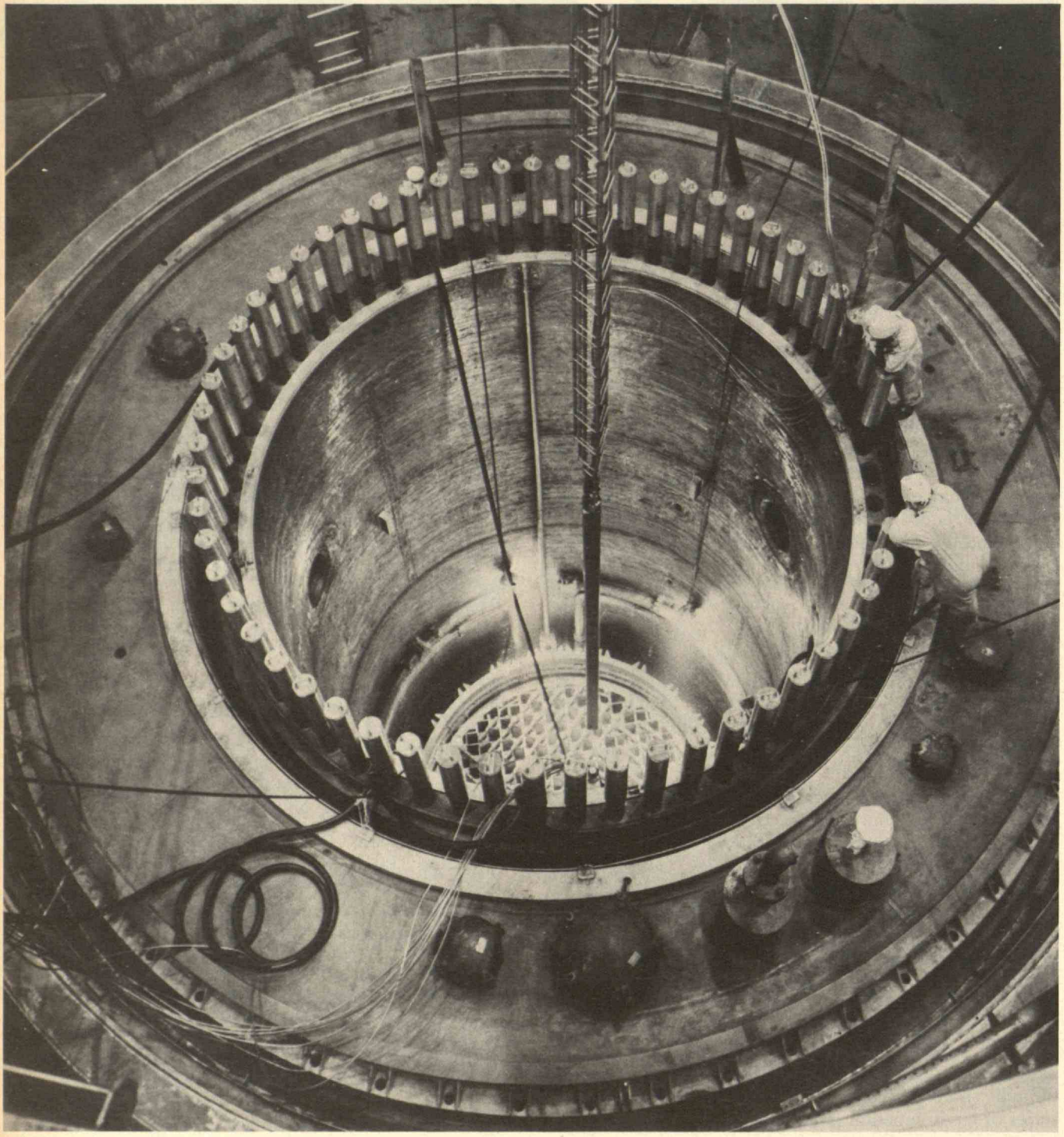
These suggest that the role of the government must change to relieve social tension. None of those "irritation" indices could be cured by industry left to itself. Either through tax policy or by direct action, these problems must be tackled by the government. The basic assumptions for Japan, Inc., have fallen apart in an extremely short period of time since 1970. First was a series of environmental issues triggered by irresponsible corporations in Minamata and Yokkaichi, which catalyzed the separation of people from business, an event equaling a samurai's departure from his feudal lord. Then came the period when people were irritated by government's inaction against industry's unchecked operations in pollution and price-hikes. Finally, this irritation of the public turned to furor during the oil crisis when industry formed cartels to maneuver market prices. This forced the government at last to cut the tie with business. The Diet called in presidents of many large corporations and publicly condemned them of their "irresponsible and immoral" deeds. The Diet also passed a number of laws that virtually ban productive investments in favor of environmental investments and employees' welfare.

Today, we find that these three sectors are cut apart and stand independently, a complete opposite of the time-honored "Japan, Inc." No one as yet knows how to reconcile this new situation. It represents a drastic change in the underlying assumptions of the Yokkakari Cycle. Without knowing the solution, the Japanese have started their venture to find another equilibrium point between the three. It is ironical that these cut-apart situations are nothing unique in the Western nations, and perhaps Japan may have to copy the answers once again.

Whether Japan will make the transition painlessly remains to be seen. Recognizing the deep-rooted existence and mechanism of the Yokkakari Cycle can be a first and indispensable step.

Kenichi Ohmae has observed Japanese industry from vantage points both outside and in. He has been a senior engineer for Hitachi, Ltd., and is now a management consultant in Tokyo with McKinsey and Company, Inc. He received a B.S. in Applied Chemistry from Waseda University, an M.S. in Nuclear Engineering from the Tokyo Institute of Technology, and in 1970 a Ph.D. from M.I.T. in Nuclear Engineering. His book "Akuma-no-Saikuru" (Vicious Cycle), Meibunsha Publishing Co., Tokyo, 1973, forms the basis for his *Technology Review* article.

Technicians lower the first fuel bundle into the 550-Mw. reactor of the Duane Arnold Energy Center near Palo, Iowa. Even as this reactor goes on line, other nuclear power plants have been delayed, postponed, or even cancelled because of their increasing cost and because of increasing public concern for their safety. But with new evidence on the latter issue from the "Rasmussen report" (*see Oct./Nov., pp. 14-15*), the nuclear power industry is preparing to take the offensive. (Photo: General Electric Co.)



Trend of Affairs

Trends This Month

NUCLEAR POWER

Nuclear Industry: New Aggressiveness

Were the nuclear power industry to adopt a mascot like Reddy Kilowatt—the cute little 1950s symbol of the electric utilities—he would be wearing boxing gloves.

At the fall Washington, D.C. meeting of the Atomic Industrial Forum, the member nuclear industrialists issued a well-heeded call to arms for nuclear advocates to aggressively challenge conservationists, nuclear critics, and the media on nuclear issues.

The basis for the industry's new chest-beating seems to be three-fold. First, the industry seems to have recovered its composure from the several years of attacks on the safety and reliability of nuclear power. Many A.I.F. speakers alluded to the "good old days" when nuclear power was well out of the public eye, and allowed that they were totally unprepared for the searing spotlight that hit them in the late 1960s and the early 1970s.

The industrialists acknowledged that they had been "tactically inept in working through the media to the public," as Chauncey Starr, President of the Electric Power Research Institute, put it.

Second, the energy crisis and fuel-cost leaps have mangled the consumer's pocketbook, making nuclear power far more attractive as a low-cost power source than it has ever been. According to one estimate, despite higher construction costs, nuclear plants can generate electricity for 20 per cent less cost than its nearest economic competitor, coal. Oil, of course, has become several times more expensive.

Finally, the recently-issued report on nuclear plant safety by M.I.T.'s Norman Rasmussen that postulated an extremely low probability of nuclear accident, has given the industry new ammunition to aim at critics. One respected writer in the nuclear field termed the report a "nuclear New Testament." References to the Rasmussen report popped up like marshmallows in hot chocolate throughout the meeting.

Predictably, outspoken critics of nuclear power bore the major brunt of the industrialists 'attacks.

"Everyone seriously concerned about health, safety, and the environment must begin realizing that there are no absolutes in life. Distasteful as it may be, we have to think in terms of costs and benefits, of tradeoffs, of comparative effects. . . . Demanding that all effects and risks to be kept to zero represents an obstructionism that has contributed more to our problems than it ever will to our solutions," said William R. Gould, Chairman of the Board of the A.I.F.

According to Chauncey Starr, "The important issue is that some of the most vocal so-called public interest groups have become empires of personal power for their leaders, who are generally not accountable to anyone for the manner in which they use that power."

Dr. Starr denounced the "babel of quasi-authorities—those parading as experts, and who, like the actors in white coats in a television commercial, are busy selling a simple solution to every complex energy issue . . . they are so convinced of their positions that they don't wish to be bothered by the wearisome process of professional review and criticism."

"There is no reason in the world that Ralph Nader should be more convincing about our industry than we are," asserted George J. Stathakis, a Vice President of General Electric.—*D.M.*

Spectres at the Feast

Despite sanguine declarations on the future of nuclear power, a number of disheartened spirits roamed the halls

at the Atomic Industrial Forum meeting (*see above*).

For one thing the buyers of nuclear power plants were having an exceedingly gloomy financial year. Skyrocketing fuel costs, stringent environmental requirements, inflation and a scarcity of capital were hamstringing attempts to bring nuclear plants on line. According to one economic survey released at the meeting, 46.4 per cent of all scheduled nuclear plants had been either cancelled or delayed, mostly because utilities simply could not get the money, either through rate increases or through loans, to buy them. The ironic result is that customers may end up paying far more for their electricity; utilities will elect to buy fossil-fuel plants, less expensive to build but about six times as expensive in terms of fuel costs to run. "The public utility industry is fighting to stay alive," warned Sol Burstein of Wisconsin Electric Power Co.

The conference participants were also nagged by the somewhat embarassing reliability record of nuclear plants. According to government statistics commercial nuclear plants had in 1973 achieved an overall capacity factor of only 58 per cent and an overall availability factor of about 70 per cent.

The industrialists pointed out that this availability is about on par with fossil fuel plants, that the average nuclear plant is far larger and more complex than the average fossil plant, and that fossil fuel plants have been operating considerably longer than nuclear plants. Also, the overall reliability figures for nuclear plants may be heavily affected by the performance of only one or two installations because there are so few nuclear plants.

But for an industry that claims to have reached maturity—the chant of many of the A.I.F. speakers—nuclear power in the opinion of many government experts has not lived up to its promise.

Federal Energy Administration Head John Sawhill (speaking on the day before his resignation): "Granted, large fossil fuel plants don't have a much better record [than nuclear plants] but that is scarcely the point. If a plant operates at only 50 per cent capacity, we must build two plants to get the output of one. Poor plant performance is inflationary, wasteful and unnecessary."

Doubts about the efficacy of nuclear power expressed by other top-level government officials also haunted the industrialists. The Project Independence Blueprint, prepared by the government and being leaked at the time of the meeting, dismissed nuclear power as a significant aid to Project Independence. "Nuclear power, the dream of the 1960s, has been plagued by technical and institutional difficulties and has only recently surpassed firewood in its contribution to total U.S. energy supply," said the report.

And about the same time, the Chairman of the President's Energy Resources Council, Rogers C. B. Morton, was telling the National Coal Association that nuclear fission is an "exotic energy source" that will not be available in quantity for at least ten years.—*D.M.*

Plutonium: A "Hot" Potato

More valuable than gold, the most toxic substance known, plutonium is rapidly becoming a paradoxical blessing-curse to the nuclear industry. More than a safety problem, "the toxicity and persistence of radioactive substances has radically altered the power balance between large and small social units," says L. Douglas DeNike, self-styled expert on the subject. With American nuclear power capacity expected to triple by 1980 and foreign capacity expected to rise 800 per cent in the same time, the prevalence of plutonium will increase rapidly. Likewise, the likelihood of a relatively small number of people bagging enough to blackmail or sabotage a city or country increases proportionately.

Plutonium, an unavoidable by-product of nuclear fission, is created when a neutron reacts with uranium^{238} inside a reactor to form uranium^{239}. Although now a waste product, plutonium will be a future fuel of nuclear reactors.

Contemplating the consequences of nuclear materials falling into the wrong hands can be extremely disquieting. Eighteen pounds of plutonium is enough to build a small fission bomb. The Rosenbaum Report for the A.E.C. on nuclear safeguards points out that "precise and accurate instructions for the manufacture of such a bomb are available in the unclassified literature." But even if a bomb were not contemplated, plutonium is still deadly—inhaling a dust-mote-sized speck can cause cancer, and dispersal of the accumulation of a year's waste from a nuclear power plant would contaminate 10,000 square miles of countryside.

Until recently the substance has been so scarce and valuable that stiff regulations covering the storage and transfer of plutonium were not thought necessary. "Only an idiot has to be told to be careful with something more valuable than gold," as M.I.T. Professor of Mathematics Daniel Kleitman put it.

Care in handling is, of course, only a skin-deep measure requiring back-up by strong regulations. And there lies the conflict: How strong must the rules governing plutonium shipment and regulation be when the most likely assailant is an organized, financed, and technically sophisticated terrorist group?

There is no motive to turn the country into an "armed camp," according to William Bartels of the A.E.C. Division of Safeguards and Security. But, for the 50 approximate reactor sites where sizable quantities of plutonium are located, "A.E.C. guards have orders to shoot to kill, and private industry has directions to get armed guards. At these locations it is necessary."

Speaking at the winter meeting of the American Nuclear Society, Mr. Bartels said, "Circumstances under which extreme violence might occur within the United States, violence which may involve nuclear activities or materials, are forseeable to some extent." He continued, "No one is proposing that existing safeguards be left 'as is' until signals indicate that terrorist attacks are imminent."

Is it possible to protect nuclear materials "so that reasonable people will agree that any risk from diversion or sabotage is negligible?" "I believe it is and at a cost which, although high, need not be so high as to cripple the economics of nuclear power," said one industry spokesperson, Carl Walske, President of the Atomic Industrial Forum. Nuclear Fuels Services President Ralph W. Deuster disagreed. As one directly concerned with the cost of enforcing stringent regulations, he holds that many of the risks are overdramatized, and that current measures are quite adequate.

The current measures referred to by Mr. Deuster met with strong criticism last spring from the Rosenbaum Report, a "Special Safeguards Study" by "five knowledgeable people who have no vested interest in the system as it now operates," commissioned by the A.E.C. Among their findings,

—"The potential harm to the public from the explosion of an illicitly made nuclear weapon is greater than that from any plausible power plant accident."

—The responsibility of guarding such materials is too large to assign to private industry, which has "neither the capability nor the desire to meet the sort of threats described."

—New accounting measures should be developed, and precise local inventories established to maintain accurate records of the amounts and locations of plutonium.

Dr. Kleitman, one of the five study group members, added, "Future quantities of the stuff will be so large that the people involved in processing will take the loose attitude that a one percent loss is not significant. When that one per cent grows to 10 or 20 kg.—enough to build a small bomb—it is

significant indeed."

The attitude of the A.E.C. is that the current regulations are not the last word but a "necessary first step." Some of their interim steps take the form of stop-gap technology: a highly reliable radio system for communicating the location and status of vehicles carrying nuclear materials anywhere in the U.S.; a specially armored truck including the radio system, protection for crew, an immobilization system, and impregnable cargo compartment; doorway monitors for examination of personnel to prevent the disappearance of small amounts of nuclear materials; non-destructive assay equipment for in-process accounting purposes.

Considering the present world political situation, one must assume that such safeguards are extremely necessary. Terrorism is increasing—Mr. Bartels counted 58 terrorist incidents involving death or injury in 1972-73 as compared to 10 in 1968-69. And other numbers are similarly gloomy: Even if conscience prevents all but one in a million people from attempting such radioactive terrorism, considering a world population of 3.8 billion, that still leaves 3,800 people to watch out for.—*S.J.N.*

Wasting the Sea Bottom . . .

About 25,000 years ago Cro-Magnon man was hunting in what is now southern Europe. Twenty-five thousand years from now nuclear wastes produced today will still retain one half-life of radioactivity and still possess a considerable lethality. Since a lot can happen in 25,000 years, the nuclear nations are faced with an extremely sticky storage problem.

There are four choices available. The first is to dump the stuff and let future generations worry about it themselves. No one favors this solution, at least not in public. The second is to bury it, a strategy still being scrutinized after at least a decade of study. This, too, has obvious drawbacks; too little can be assured about subsurface behavior in many parts of the U.S. The third and superficially most appealing solution has already been ruled out by N.A.S.A.—to launch the wastes into space. Besides footing the enormous expense of dumping the nuclear garbage in outer space, N.A.S.A. does not wish to put itself in the position of having to guarantee success for each shot. The fourth solution is to dump the nuclear wastes into the sea.

Charles Hollister, oceanographer at Woods Hole Oceanographic Institution, who is studying the problem with a team of experts, believes this fourth alternative to be no better than the first three. Even if the radioactive wastes were diluted by all the water in the seas, "at projected production rates, all the oceans would be polluted by the year 2000."

Neither are the ocean floors so vast a dumping ground for impregnable containers of nuclear wastes as they seem at first glance. Dumping in the "ring of fire" around the Pacific, or any other seismically active area, would be foolhardy. The same argument applies to dumping or burying radioactive waste in or near any potential resource area—imagine an underwater manganese miner plowing its way into a keg of plutonium.

What about temporary storage—hiding the nuclear waste somewhere on the sea floor where it can be retrieved and checked periodically for leaks or movement? No, says Dr. Hollister. If plutonium is placed on the sea floor, with access by a certain group, a priesthood has been effectively created that controls this dangerous material. They could conceivably use the material for nefarious purpose.

Speaking at the Scientific Convocation for the Clark Laboratory Dedication at Woods Hole this fall, Dr. Hollister emphasized that recently acquired knowledge about plate tectonics and sea floor formation must be taken into account when searching for a dumping ground that must last 25,000 years. Dumping would be impractical near proven plate boundaries, such as the mid-Atlantic Ridge; movements in those areas have been verified, and the extents and directions of those movements make dumping there an uncertain proposition.

Although Dr. Hollister can say with conviction that the sea floor would make an impractical, even dangerous, disposal ground, he cannot be quantitative about the difficulties at this time. Only sketchy information exists about the ocean floor and its rates of process—in this case the speed and direction of dispersal if a cannister were to leak, or the rate of cannister burial or movement.

Evidence that will hopefully settle the issue is now being collected by a team of biologists, chemists and oceanographers. They are studying an area in the Central North Pacific that does not experience earthquakes, is limited in desirable resources, has only sluggish currents, is reasonably far from the nearest plate boundary, and "seems most stable at the moment." Since the A.E.C. now stores their nuclear wastes in vats for 30 years, hoping in that time to find an effective disposal area, there may be time for Dr. Hollister and his colleagues to collect enough information to prove (or disprove) their contention. But right now, says Dr. Hollister, "I wish we didn't have the problem at all."—*S.J.N.*

. . . and the Ground

Transportation and storage of plutonium are not the only problems to consider in dealing with nuclear wastes. Nuclear experts are only now beginning to realize the complex and subtle effects of a plutonium leak.

Until recently, soil chemists believed that plutonium remained chemically inert when absorbed into the ground. Large, concentrated radioactive spills obviously poisoned plant life in the spill area, but small or well dispersed spills were thought to be innocuous.

Recent laboratory studies on plutonium effects in plants disprove this simplistic assumption. Plants do absorb plutonium from the soil, just as they may take in any trace elements in soil to which they are exposed. Dr. Raymond R. Wilding and Thomas R. Garland of Pacific Northwest Laboratories, writing in the *Journal of Agriculture and Food Chemistry* this fall, suggest that the researchers who "proved" plutonium to be inert in the soil could have been misled by inferior measuring techniques. Ten microcuries of plutonium per gram of plant material, the smallest dosage measurable by customary chemical techniques, contains enough radioactivity to damage a plant. "Higher levels of plutonium necessary for the measurement by the techniques used may have caused chemical or radiation damage to the roots and could have limited the plutonium uptake of the plant," Drs. Wilding and Garland said.

The scientists used instead a "split" root technique, whereby roots of test barley plants extended through a soil layer, through tubes, into nutrient containers. This technique enabled precise measurements at low concentrations by providing soil-free samples and exact areas of exposure. The chemists added measured amounts of plutonium to the soil, and analyzed both the plants and nutrient solutions containing the lower roots. Though they discovered no plutonium in the nutrient solutions, there were varying concentrations in the roots in the nutrient solutions—all of which originated from the soil layer.

The researchers found the concentrations of plutonium to be three to eight times higher in the plant roots than in the shoots. Besides being absorbed directly from the soil into the roots, the metal was also distributed downward by the root system. As expected, plutonium concentration in the living plant decreased with decreased soil concentration. However, the ratio of soil to plant concentrations increased with lower plutonium concentration.

Robots meet cars. Teams of Unimate robots synchronously perform large numbers of spot welds on an automobile assembly line. The president and founder of Unimation, Inc., maker of the world's largest selling industrial robots, predicts sophisticated and ubiquitous robots in America by 1984. (Photo courtesy of Unimation, Inc.)

"The difference [in plant plutonium absorption] may be attributed to microorganisms which convert plutonium to a more readily soluble form, organisms which, while active in the presence of low concentrations, are killed in the presence of more radioactive material." Drs. Wilding and Garland also theorized that the decay of plutonium-containing roots also works upon that metal to make it more available for absorption by plants.

The continuation of their studies is especially vital, they say, because of one implication of their findings. If a plutonium spill occurs, "root plants directly consumed by man (potatoes, beets, carrots) may contain plutonium at levels exceeding those found in other crop plants in which the tops are consumed. The apparent concentration of plutonium in the roots of plants makes it essential that the potential for plutonium entrance into the food web be assessed."—*S.J.N.*

COMPUTERS

Robots in Your Future

"Good afternoon sir or madam, as the case may be. Welcome to MacRobot, the world's first robot-run hamburger stand. Place your order by naming the items you wish in a clear voice into the speaker in front of you and placing the money in the tray.

"As you watch the ceiling-mounted and mobile robots preparing your meal, I will tell you something about our operation. Merely press the red button for a history of us robots.

"Ten years ago, in 1974, such robots as you see were accurately predicted by Joseph F. Engelberger, President and founder of Unimation, Inc., the world's largest producer of industrial robots. Back in 1974, Mr. Engelberger and his associates had already produced Unimate, essentially a computer-driven mechanical arm with a dexterous claw attached. Unimate and its cousins performed simple assembly tasks, transferred hot forgings in die-casting plants, welded car bodies, and performed other dirty or tiring tasks unpleasant for humans.

"The robots had several capabilities that made them practical: They were fast and easily programmable by leading them through the task to be performed. They were accurate to 3 millimeters and could handle up to 150 kilograms. They could synchronize with moving assembly lines, and could move objects from point to point, or follow prescribed paths. They were easily linkable with master computers, and were highly reliable and economical—a $32,000 Unimate was functionable 97 per cent of its lifetime, and usually repaid its investment in a couple of years.

"But even in those primitive days of 1974, Mr. Engelberger foresaw a highly advanced robot economy based strictly on developments he had already witnessed in university and private research laboratories.

"Robots, he said, would develop rudimentary vision, at least enough to orient work objects and recognize when they were correctly placed and in good order. Advanced tactile senses would allow the same sort of recognition by touch and a governing computer would interpret this visual and tactile data. Robots would have multiple appendages and hand-to-hand coordination, with energy-conserving musculatures, and general purpose hands that could perform many duties, predicted Mr. Engelberger. In 1974, each time a robot's task was changed, its hands were changed. Robots would also become smaller, and more human-shaped to fit into the human spatial environment.

"Humans and robots would be able to communicate by voice, as we are doing now. And, as you can see, his predictions were accurate, based as they were on experience in the hard-headed, economics-oriented business world.

"He predicted not only robot-run hamburger stands, but robot-run gasoline stations. In such an establishment, an arriving customer would feed his or her credit card into the robot. The credit card would contain credit information and also the make and model of the car, directing the robot to the location of the gasoline tank filler spout.

"Mr. Engelberger predicted that customers would welcome such a development: 'Most of us are tired of having that same old how's-the-weather conversation anyway,' he told students at M.I.T. Robot garbage collectors and robot housekeepers that could repair appliances or even detain intruders were predicted.

"Mr. Engelberger foresaw that humans and robots would enter into a symbiotic relationship, with each af-

fording advantages to the other. And he was right, for even in 1974 there was little labor opposition to the introduction of his robots. This was made possible in part by management's practice of introducing robots gradually, replacing only those employees lost by attrition. The major question in those days, according to one labor official, was what trade guild the robots would belong to.

"Ah, here is your meal. Eat hearty, and good day sir or madam, as the case may be."—*D.M.*

The Coming Age of Automated Markets

Only one new machine stands between today's inefficient, labor-intensive supermarkets and the "electronic age of automated food shopping," says J. Francis Reintjes, Professor of Electrical Engineering at M.I.T. The missing link is a computer-controlled order selection machine that could withdraw items from stock in response to instructions given by a shopper with punched cards or over a touch-tone telephone.

Such a machine would require no new technology, thinks Professor Reintjes—simply "a new synthesis of existing technology from a complete systems viewpoint."

Reporting on a study completed for the National Science Foundation by M.I.T.'s Electronic Systems Laboratory, Professor Reintjes writes that "the potential of modern technology far exceeds its present utilization" in food handling, distribution, and retailing. Substantial savings through improved efficiency and reduced labor costs would result from automation of the kind proposed by Professor Reintjes and his colleagues.

Four visions of the future are contained in the E.S.L. report
—Automated warehouse-to-door shopping systems
—Automated retail "superstores"
—Automatic "minimarkets"
—Mobile automatic markets

Let a shopper who prefers not to (or cannot) travel to a grocery store dial the warehouse on her touch-tone telephone, and then use the same touch-tone system to give the code number of each product and package on her shopping list. The computer-controlled order selector in the warehouse identifies her items, picks them off the shelves, prints an itemized invoice, charges her account, and puts her order out for delivery. Widely used, says the E.S.L. report, such a system would eliminate all retail supermarket costs with "self-evident" savings.

Or perhaps a shopper chooses to go to the nearest "superstore." There she would find a display with a sample of every product available, marked with number and price. She takes a punched card corresponding to each item she wants and feeds her deck of cards to a computer. The computer tallies her bill, and when she has paid it her order is automatically assembled from the store's stockroom and delivered to her car. The check-out counter—the most costly feature of supermarket shopping in terms of both time and labor—is eliminated, and so is the multiple handling of merchandise involved in keeping supermarket shelves supplied.

For the elderly, whose shopping lists are often short, the E.S.L. suggests automated "minimarkets"—the successor to the "traditional 'mom-and-pop'-type corner store"—carrying only 300 to 400 different items. Such small stores could operate automatically, almost unattended—in general in the same manner as the automated "superstore."

Such a store, mounted on wheels, becomes a mobile market serving many neighborhoods during each day.

Will consumers take to automated food retailing? There has already been one "major shift in shopping procedures" during the 20th century—from the corner grocery to the supermarket—and Professor Reintjes and his associates think "the consumer is fully capable of making a second major shift to the electronic mode, provided . . . automated shopping systems are made attractive, economical, convenient, and simple to use."

A more difficult problem is the capital for development. "Costs will be high and the payoffs will not be sudden," and the E.S.L. engineers suspect that joint funding by food retailers, manufacturers, and the government will be necessary.—*J.M.*

MASS TRANSIT

You Gonna Get 'em Down on the Farm?

The most massive migration in the history of mankind has occurred in the United States over the last century. An influx of people from the countryside into the cities took place, because of opportunity in city factories and lack of opportunity on the mechanized farm. Before the migration, the population was two-thirds rural, one-third urban; 100 years later 75 per cent of all Americans lived in cities.

Communications pioneer Peter Goldmark thinks that this influx can be reversed, and that "the new rural society" can free people from the endemic pollution, social problems, and crowding of the city. He points out that overcrowding is uniquely responsible for many of our problems—both crime and air pollution levels are about four times higher per unit of population in cities of one million than in towns of 10,000.

According to Dr. Goldmark, people do want to live outside the city—about 50 per cent have said that they would move to the country given the opportunity. About 70 per cent of minority groups in cities want to leave for rural places. In a study now underway for the Department of Housing and Urban Development, Dr. Goldmark and his colleagues identified five drawbacks to rural life that he says can be alleviated by improved communications systems: lack of jobs in small towns, inadequate health care, poor educational facilities, limited cultural and recreational facilities, and the lack of opportunity for people of like interest to get together. Dr. Goldmark spoke at the autumn meeting of the National Academy of Engineering in Washington, D.C.

The inventor of the long-playing record, the videotape cassette, and the first workable color TV contends that further communications advances can make it possible to relocate many jobs into the country, with communications by videophone, or even conference telephone calls and facsimile transmission over phone lines. Television-taught extension courses could bring quality education to adults and children alike in the new rural communities, and medical consulting could be done to some extent by videophone. Cultural events could be transmitted to community centers in rural towns, and the fast-approaching video-disc system for recording and playing back television shows could become as common as the long-playing record.

Dr. Goldmark's pilot project in rural Connecticut has already demonstrated that many business communications could be done by telephone.

This spread of population will not increase the transportation and energy needs of the country, says Dr. Goldmark, and will in fact reduce them. Commuting, the major transportation need, will be reduced because people could live quite close to their jobs. The enormous power plants to generate electricity for high-population densities could be replaced by smaller coal-burning plants, made environmentally feasible because pollution would not be so dangerously concentrated. Shipping would be computer-controlled to make efficient the complex routes necessitated by a diffuse population.

The major obstacle to this migration apparently is psychological—people must come to believe there is opportunity in them thar hills.—*D.M.*

Computing the Commuter

Dr. Goldmark's urban-rural balancing act (*see above*) will be made more feasible by a new revolution in transportation, said Robert H. Cannon, Jr., formerly the Assistant Secretary for Systems Development and Technology in the Department of Transportation, now Chairman of Cal Tech's Division of Engineering and Applied Science, at the same National Academy of Engineering meeting.

Past transportation revolutions were caused by new methods of levitation and propulsion—the wheel, and later, roads and the airplane wing, and steam, gasoline and jet engines. Without these breakthroughs the remarkable productivity of the United States would not have been possible, entailing as it does the coordinated movement of ideas, people and goods.

The future transportation revolution will result from a device not strictly associated with transportation—the digital computer. The computer will not only be a working member of a more productive transportation system, but will enable understanding the best deployment of transportation resources, and even their environmental and economic impact.

The diffuse structure of a large rural society would be difficult to manage without a computer-controlled system of optimizing shipping routes and transfers between transportation modes. The first steps are being taken in computerized management of freight cars; a code stenciled on the side of each car is read by a computer reader at trackside, and so the computer records where each car is at all times.

The energy crisis, in fact, will almost dictate that the digital computer be used to increase the efficiency of transportation. Dr. Cannon cited the possibility of a complete origin-to-destination trip-managing computer which when fed desired origin and destination could instruct the user what mass transit modes to take where, and could even issue tickets and order up individualized transportation such as dial-a-ride where necessary. Can public transportation thus come to rival the automobile in giving convenient, point-to-point service?—*D.M.*

DECISIONS

The Brain Drain: Turning Against Us?

When a young person from the Camerouns goes to France for an advanced education at government expense—250 of them attend French universities in this way every year—the Camerouns government invests some $80,000, including overhead. If the student fails to return to the Camerouns, that investment is "down the drain," and this kind of "brain drain" has been costing the Camerouns some $7 million a year.

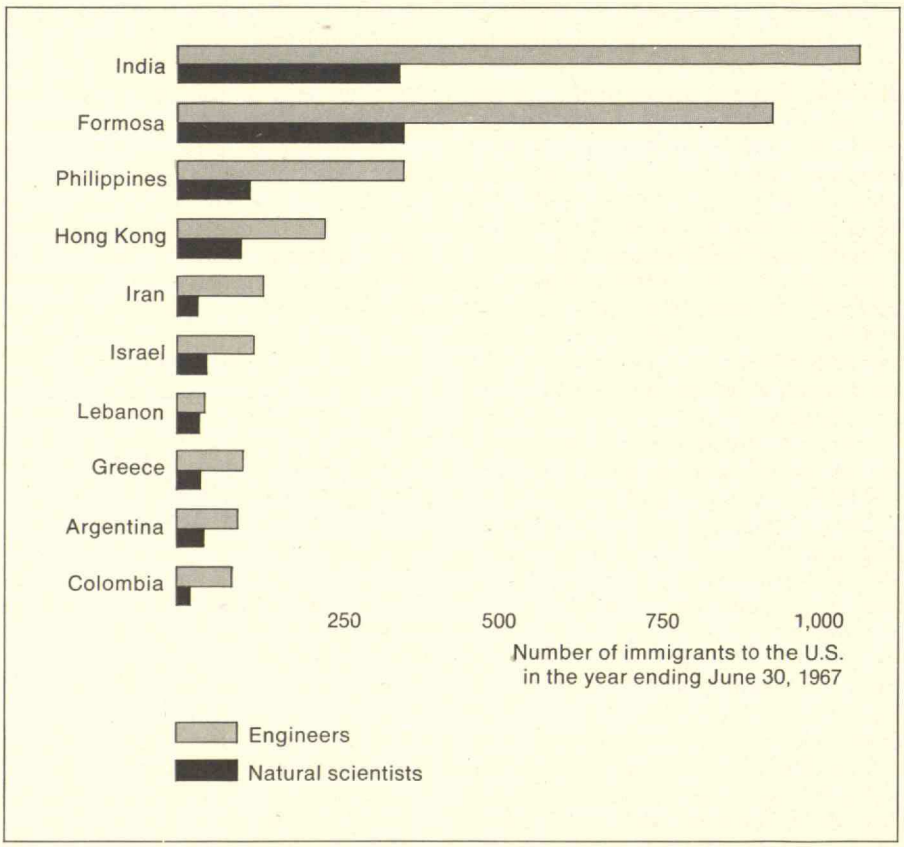
Indeed, the lure of the developed countries for the educated elite from the world's less developed countries (L.D.C.s) results in a substantial and continuing drain of talent and resources which the L.D.C.s can ill afford. A 1970 United Nations report puts the investment of Lebanon in elementary and higher education for experts who subsequently emigrate to take advantage of better jobs and resources elsewhere at $40 million annually; Colombia's loss may have been over $180 million in the 12-year period beginning in 1955, and the drain of skilled manpower from Trinidad and Tobago in 1968 alone may have wiped out a $21.2 million investment in education by that two-island commonwealth.

The result, thinks Joseph G. Whelan, Senior Specialist in International Affairs with the Congressional Research Service, is to accelerate the widening gap between advanced and less-developed nations, to cloud international understanding, perhaps even to dilute the genetic resources for future generations in the L.D.C.s. Latin Americans, for example, perceive the migration of professional people "as a formidable barrier to national progress," writes Dr. Whelan in a study of the "brain drain" prepared for the House Committee on Foreign Affairs this fall.

But will the tables soon be turned, making this "brain drain" an Achilles heel for the advanced countries who, so far, are unilateral beneficiaries?

Perhaps. Consider our growing dependence on the underdeveloped world for essential energy and mineral resources. If the gap between developed and underdeveloped is widening, the sense of nationalistic competition in the L.D.C.s is deepening. Hence there is growing pressure there for nationalization of foreign-based industries exploiting natural resources.

But have the industrialized nations so depleted the L.D.C.s' technical manpower resources that these countries, having isolated themselves from our expertise, will be unable to fulfill our need for their products? Self-interest as well as public spirit may well motivate us to find ways, in Dr. Whalen's words, "to put the L.D.C.s on a . . . self-reinforcing upward spiral of social and economic progress."—*J.M.*



The U.S. is one of the principal beneficiaries of the International "brain drain" as scientists and engineers are drawn from L.D.C.s by what they deem to be superior opportunities here: nearly 20,000 engineers and 8,000 natural scientists between 1962 and 1966, 8,800 engineers and 2,900 scientists in 1966-67 alone.

Curbing Atomic War in an Insecure World

Our policy of deterrence may have prevented nuclear war since World War II, but the truth of this is really unknowable because of the many implicit political, technological, social, psychological, and moral uncertainties in society. It may be said, however, that our almost slavish dependence upon naked nuclear deterrence is really more theology than science, and it could lead to catastrophe.

Thus was the "American intellectual community" scolded for its "thinking on arms control" by Fred C. Ikle, Director of the U.S. Arms Control and Disarmament Agency, at a Harvard/M.I.T. Joint Arms Control Seminar early last year. Their potentially disastrous mistake, he said, "is in forgetting that our policies for preventing nuclear war must succeed indefinitely" in a world of uncertainties.

Can the essentials of deterrence be calculated in advance? Perhaps, but these analyses cannot be relied upon. Dr. Ikle cited "missile duels" as a prominent example of a problem that has been tailored to our ability to calculate. Seemingly rigorous models are built on the rule: what you can't calculate you leave out. Fallout is ignored in missile-duel models. So are nuclear bombers and sea-based missiles and their possible interactions, the existence of non-major powers that possess nuclear arms, and intellectual evolution in strategic thinking.

Like no other field of endeavor, nuclear deterrence lacks empiricism. By definition, there can be no trial and error learning. We pretend we can analyze all that is relevant, Dr. Ikle said. "We work with simplistic abstractions and are not too troubled by the discrepancies between these abstractions and the possible reality . . . that is so hard to imagine."

What other weaknesses in our deterrence policy does he see, besides an over-emphasis on numerical calculations? One is a "widespread belief" that nuclear deterrence is all that counts. Most professionals who think about prevention of nuclear war know deterrence could fail not only because of an inadequate retaliatory capability, but also for such reasons as accident, unintended escalation, or unanticipated (or unimagined) combinations of failures. "Yet," the A.C.D.A. leader said, "nearly everyone keeps debating arms control policies and nuclear strategy in terms of naked deterrence."

The Immorality of Naked Deterrence

The danger of relying on naked deterrence is heightened by "the unpredictable perils of split-second alert procedures" that leave no time for correction. This is a particularly immoral policy. Said Dr. Ikle "Many arms control specialists maintain that deterrence requires the threat of genocide, although they would call it 'mutual hostage relationship' . . . According to this thinking, a deterrent will succeed as long as—according to our calculations about 'missile duels'—it can result in enough people killed on the other side.

"Actually, the more simplified the calculation, the greater is the distance between this atrocious abstraction and the incomprehensible, real atrocity for which it serves as a disguise."

And yet, there is no proof that the mass murder of innocents is the only way to deter nuclear war, nor that it is even an effective way.

Dr. Ikle advised the Harvard/M.I.T. audience that not only should we avoid planning this country's arms control policy on the basis of intellectualized abstractions and fictions, but we should inject some "moral conscience" into the policy. We should be concerned about the built-in usability of nuclear arms, he said, for they are carefully primed for ready use. If there were a decision, deliberate or accidental, to launch nuclear war, the blame for "the ensuing cataract of horror" would be on the society that failed to avert disaster.

Should deterrence then be done away with? Only naked deterrence, Dr. Ikle said. Deterrence must be supplemented by positive actions in the technical, military, and political fields. He recommended a few such actions that ought to be started on many intellectual fronts at once:

—Engineers and physical scientists should develop less dangerous nuclear arsenals and invent arms that can survive nuclear attack. New arms control agreements should encourage such development.

—A high-priority task in command and control and operational planning is to provide for reversibility of crises. The Washington-Moscow Hot Line might be useful, but this generally neglected field cries for constructive technological and political inventions.

—Traditional arms-control agreements to limit specific weapons should be re-emphasized. Any process of reduction of nuclear armaments could help throttle bureaucratic arms competition, and could lead to safer deployments of nuclear forces.

—The intellectual community should also pay closer attention to the uncertainties of the real world, changing local sources of conflict that could drag us into nuclear confrontations, shifting alliances, and the proliferation of national nuclear forces and their hostile juxtapositions.

Dr. Ikle urged a re-examination of our premises, a willingness to study our own cultural strait-jackets as well as those of our adversaries. "Comfortable notions," he said, "such as 'mutual deterrence', 'strategic stability', and 'safe retaliatory forces' should be regarded as hypotheses in a continuing search for better solutions—not as declarations of faith. A declaration of faith, according to an old Portuguese expression, is an *auto-da-fé*, an act that ends in a mass burning."—*Ralph Segman*

How and Why to Export Technology

When it comes to selling technology overseas, you're on your own—sometimes. Would a better understanding of the national interest help? Yes; almost everyone's agreed on that. Would a more decisive government policy help? Yes; but what should that policy be?

Some of the issues which make exporting high technology a difficult business, as listed by panelists at the annual meeting of the American Institute of Aeronautics and Astronautics in Washington last year:

—Are we exporting technology at a faster rate than we're creating it? And does it really matter, whether we create the technology we use or import it from someone whose costs may be lower than ours would be?—the key issues as raised by Daniel J. Fink, Vice President of General Electric Co. (He was taking office as President of the A.I.A.A. at the Washington meeting.)

—High technology is perishable; if we don't export it someone else will. And high technology is hard to price; you pay for both failures and successes, but the buyer wants to buy only the successes, said Richard D. DeLauer, Executive Vice President of TRW, Inc.

—Working people, who share heavily in the costs of research and development, are not well served when the fruits of that work are sold overseas by multinational companies to create jobs there and unemployment at home. There is a "clear market advantage to those who have technology; let's keep ours at home."—strongly worded advice from William W. Winpisinger, General Vice President of the International Association of Machinists and Aerospace Workers.

—High technology means different things to different people. To underdeveloped nations computer technology will be useless but manufacturing technology is probably just what the doctor ordered. Some problems: differences in patent protection accorded by different nations to different products, different arrangements by different nations for the exporter of technology to share in the fruits it yields for its importer. "It simply isn't clear how to deal with

these distinctions," said John D. Holmfeld (M.I.T.'57), a member of the staff of the House Committee on Science and Astronautics. And, in any case, he said, "our tradition of leaving the private sector to make its own deals means that we do not know what is really going on—at home or overseas—in the matter of technology transfer."

—"We're selling less technology than we're creating," and that's the name of the game: use our resources to stay out in front, and if we succeed then technology transfer will always represent a profit opportunity, not a threat, said Robert C. Seamans, Jr., President of the National Academy of Engineering.

After these conflicting comments, it fell to Ambassador William D. Eberle, President Nixon's Special Representative on Trade Negotiations, to find the middle road: We are importers as well as exporters of technology—remember the radial tire and rotary engine. If we act to limit technology export, we risk retaliation which limits our technology import. On balance, said Ambassador Eberle, the only way you can maintain an active, competitive economy is to maintain a major role in world markets—and that includes technology. Hence, he said, the government's policy of limited intervention (only when national security seems to be at stake) in industry's decisionmaking.

But that was hardly satisfactory to Mr. DeLauer. "The folks on Pennsylvania Avenue seem to be pleased with some of our activities," he told the meeting, "and troubled by others." At least in the aerospace industry, he said, we need some help on making decisions.—*J.M.*

Study Social Costs, Not Technology

Public transit in the U.S. faces some grave problems—"the condition of the patient is still very grim"—but technology is not one of them.

Engineers, transit experts, and educators who spend their time devising exotic new transport schemes that end up on the Sunday supplement pages do more harm than good, thinks Louis J. Gambaccini, Vice President of the Port Authority Trans-Hudson Corp. (it operates the PATH system, successor to the Hudson and Manhattan Railroad).

The real problems on which Mr. Gambaccini wants some advanced thinking have to do with computing social costs and social values—cost-benefit studies which will show how much society should spend on public transit by showing who will benefit, and how much. And there should be studies of how transit planning should be coordinated with housing and other urban programs.

Such high-technology public transit proposals as guideways, magnetic vehicles, and personal rapid transit systems are a red herring which give the public and especially government officials false hopes of exciting, early breakthroughs. And while the officials use this excuse for procrastination and the taxpayers compare their buses with these Buck Rogers visions of speed and comfort, public transit lacks the massive, coordinated support it needs—and needs now.

Mr. Gambaccini, who spoke this fall at a seminar of M.I.T.'s Center for Transportation Studies, says that despite growing federal aid for mass transit, "the industry can barely manage a state of survival. . . . Most of the present money," he said, "is going into a 'baling-wire-and-Scotch-tape effort' to keep what we have operating."

True, the American attitude toward mass transit is changing; there is substantial public pressure, he thinks, to expand and build new systems. But lots of people think of the industry in conventional profit-and-loss terms—a holdover from the halcyon days before the automobile was king. Now we have to understand that mass transit is "a growth industry with little profit potential"—hence Mr. Gambaccini's concern for a new understanding of social costs and social values to replace the conventional corporate balance sheet when it comes to his industry.

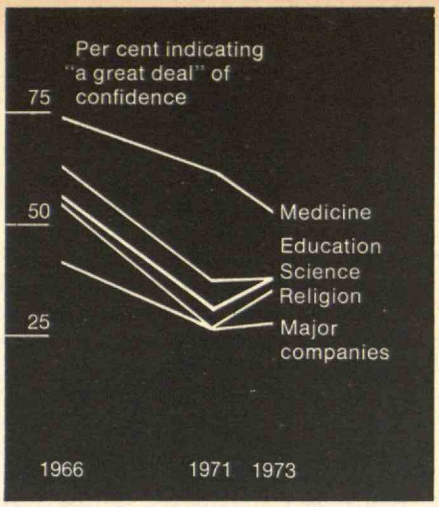
PATH is a case in point. In 12 years since the Port Authority took over the bankrupt line a total of over $220 million has been invested to modernize it; the system is hardly longer now than it was then, and passenger volume is lower than in the 1920s. But over 65,000 riders now use PATH at rush hours every day—more than ever before in its history—and for them (and therefore for the economic health of lower Manhattan) PATH is a necessity.

How to represent that on PATH's balance sheet is Mr. Gambaccini's problem.—*J.M.*

Science: Gaining New Confidence?

After a decade of growing public discontent and disillusionment with science, are we really not so distrustful after all, perhaps regaining our sense of science as an "endless frontier" from which springs comfort, wealth, and power?

After a comparison of Harris Polls, Amitai Etzioni, Professor of Sociology and Director of the Center for Policy Research at Columbia University, reports in the summer issue of *Daedalus* that the anti-science movement may have peaked, that public interest and confidence in science is once again on the rise.



Harris Poll data suggest that science has always enjoyed more public confidence than many American institutions. Declining faith in all institutions has been characteristic in the U.S. in the last decade; now science, along with most—but not all—is regaining lost ground. The 19 per cent net decline in science support shown above is "moderate relative to the eclipses suffered by other institutions," wrote Amitai Etzioni and Clyde Nunn of Columbia University in the summer issue of *Daedalus*.

The decline in public confidence in science in the 1960s was part of a general "lessening of faith in most American institutions," thinks Dr. Etzioni. "It was not a major anti-science groundswell," he told the American Association for the Advancement of Science last winter in a preview of his *Daedalus* analysis. And the most encouraging thing of all is that public confidence has returned more rapidly to science than to other societal institutions. By the spring of 1973 science and education (tied) were outranked only by medicine in eliciting "great confidence" from the U.S. public.

Dr. Etzioni reached these conclusions by comparing Harris Polls on the issue of public confidence in 16 major American institutions, including medicine, science, education, finance, government, and others. He and his colleague, Clyde Z. Nunn, also of Columbia, found a sharp decline in the number of people expressing "a great deal" of confidence in science between 1966 (56 per cent) and 1971 (31 per cent). But a year later 37 per cent indicated great trust in science, and the same figure was repeated in 1973.

Much the same thing happened to

the other 15 societal institutions—a sharp decline in public trust between 1966 and 1971; then nine of them experienced a slight rise in 1972. In 1966 and 1971 science was fifth among all 16 institutions in terms of public confidence; by 1972 it was third.

Dr. Etzioni thinks the result is encouraging—a general reestablishment of faith in institutions that represent modernity and progress; according to the Harris Poll data, 41 per cent of those aged 18 to 29 expressed "great confidence" in science; so did 49 per cent of the college-educated. But, as Dr. Etzioni admitted, a 37 per cent confidence level still leaves many people in this country uneasy and distrustful of science. And his *Daedalus* report shows that science has still to regain "a great deal" of confidence in the eye of nearly 20 per cent of the U.S. population before it recovers the position of respect accorded it in 1966.

Produce More to Stay Ahead

"Engineering is determined by where we are," says J. Herbert Hollomon, Director of M.I.T.'s Center for Policy Alternatives. And where we are now, he told the M.I.T. Alumni Advisory Council this fall, is productivity—the key to inflation and to future U.S. world leadership.

For the last two decades, the productivity of almost every other nation in the world—measured per unit of labor or capital invested—has grown faster than that of the U.S. Indeed, U.S. productivity has grown little if any since 1950, and our present inflation could have been substantially offset, says Dr. Hollomon, if our productivity since 1950 had grown at its historic rate. The single exception is agriculture—U.S. farms have the highest productivity growth rate in the world.

One reason for our present problem is the enormous technical effort devoted by the U.S. to space and defense in the 1950s and 1960s. It's not by chance, thinks Dr. Hollomon, that the nations which now lead in industrial innovation are Germany and Japan, the two nations that were prohibited from investing in military establishments after World War II.

Another reason: The U.S. has evolved into a service economy, and productivity is hard to manage in service-oriented industry. In this situation the traditional engineering disciplines—civil, mechanical, metallurgical, even aeronautical—have little to contribute. Information technology is the most important element in a service economy, and it is no accident that our most effective high-technology innovation is now concentrated in the information business—communication, computers and management.

But grounds for optimism. From communications and computers it's a small jump to increasing productivity again through automated, computer-controlled manufacturing. And that, thinks Dr. Hollomon, is the future course of U.S. technology.—*J.M.*

Engineers: Head for the Hospitals

There's nothing wrong with bioengineering: Still lots of needs, lots of jobs, but the needs are at the practical level of putting hardware in touch with patients. Most of the jobs are not in esoteric research but in the hospitals.

This was the conclusion (though not unanimous) of members attending the first meeting this fall of the Engineering in Medicine and Biology Chapter of the Boston Section of I.E.E.E.

Professor Lawrence R. Young, who directs the Man-Vehicle Laboratory at M.I.T. identified three levels of biomedical engineering: The simple use of one technology (engineering) in another (medicine), which really represents no interdisciplinary action at all; a deeper penetration, through which an application of technology actually alters the discipline (medicine) to which it is applied; and a true interaction when two disciplines work on a problem which is at the very interface between them.

Engineers can work at the first level of biomedical engineering without any biological training at all; the second level demands some special biological and medical knowledge as well as engineering competence. To work at the third (interface) level you need to be at once an engineer and a doctor. This is an eight- or nine-year proposition leading to a Ph.D. or M.D. degree as well as an engineering baccalaureate, representing an investment of at least $75,000. Professor Young's advice to students who want to work this way is to complete an engineering degree, then start in on a doctorate in biology or medicine.

But that field is limited, thinks Professor Young. There are 300 to 400 such biomedical engineers in the U.S. today, and that may be about as many as we need.

Most U.S. bioengineers—perhaps 7,000 in all—are really engineers with little or no formal biological training who happen to enjoy the challenges of the life sciences. A few are in hospitals, where, said Professor Young, "a resident bioengineer is not a luxury but a necessity," and it's here where the future lies.

Dr. Edward Peizer, Assistant Director of the Prosthetics Center for the Veterans Administration in New York, agreed. "Hardware is coming down like a torrent," he said; the problem is to find people who know how to use it. Dr. Peizer described a new kind of professional—a clinical engineer, whose specialty is using engineering devices to treat and help patients. He is at Professor Young's second level of expertness; he needs to understand what patients need, but most of all he needs to understand (not to invent) the technology he uses—the functions and limitations of hardware—how it works and how to keep it working.

Will such a clinical engineer always find a warm welcome at a hospital? Almost always, thinks Dr. Peizer, Every hospital, he says, has its storeroom full of dusty equipment which doesn't work and can't be fixed because no one knows how it is supposed to work. But let a bioengineer be prepared for some surprises, too, for his role is not really understood. Let him be ready for the hospital director who greets him warmly because "I've got this elevator that hasn't worked for two years . . ."—*J.M.*

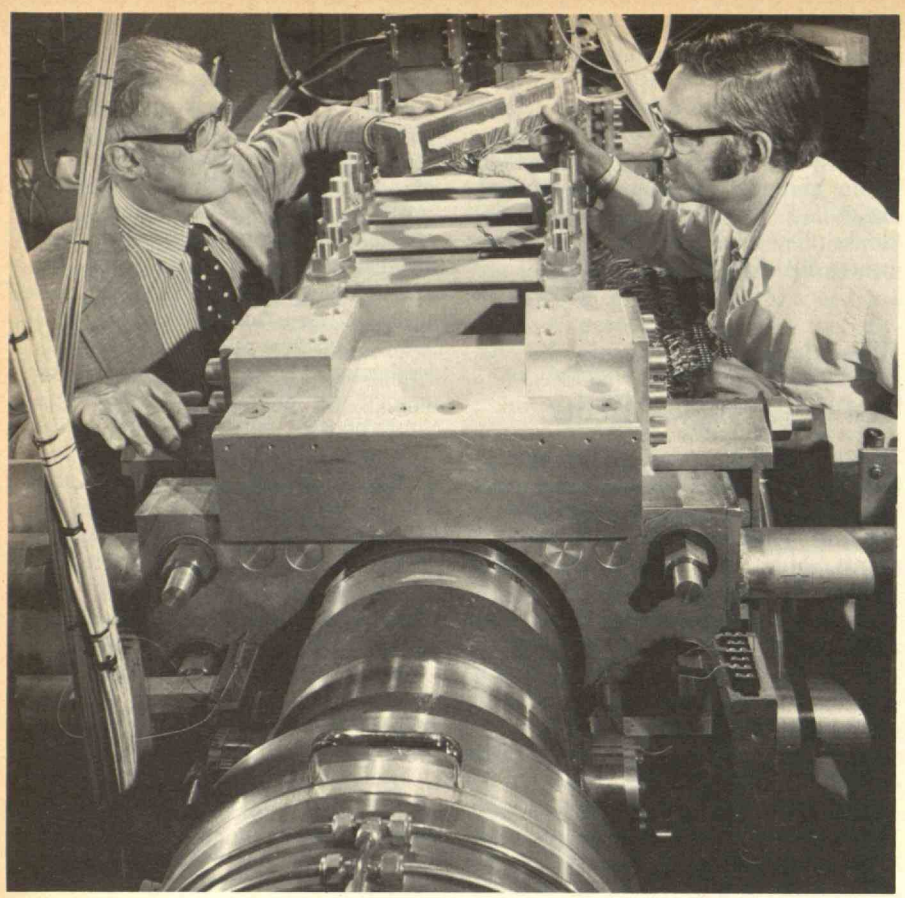
ENERGY

More Power to an Old Idea

It is a matter of timing. Abundant oil and gas are no more . . . now support is given to new ways of wresting additional power from the traditional fuels. Magnetohydrodynamics (M.H.D.) is theoretically capable of producing a substantially larger yield of power from each pound of fuel (coal, petroleum fuels, natural gas) than is now produced in conventional generators. And there would be fewer pollutants.

The principle is an old one: When a material that conducts electricity is passed through a magnetic field, current flows. But in a conventional generator the magnetic field surrounds a rotating metallic conductor. In the M.H.D. power plant, hot gas acts as the electrical conductor. The gas, "seeded" by adding small amounts of metal, is pumped into a channel running through a strong magnetic field. The electric current produced is tapped by terminals at the tunnel's end.

Two different M.H.D. generators, open- and closed-cycle, are now being studied. In the open-cycle version, combustion gas obtained from burning coal, natural gas, or any other fuel is heated to about 5,000° and injected with potassium compounds to provide electrical conductivity. After the gas passes through the magnetic field, the



A blast of hot gas roaring at 3,000 miles-per-hour down this 60-foot-long tunnel at General Electric's Space Sciences Laboratory has given new hope to advocates of magnetohydrodynamic (M.H.D.) power. A series of closed-cycle M.H.D. tests by Dr. Bert Zauderer (M.I.T. Ph.D.'62), and his colleagues in G.E.'s closed-cycle M.H.D. research program has demonstrated conversion of 20 per cent of the heat generated in the shock tube to 1,800 kw. of electricity in hundredth-of-a-second bursts. Nine years ago the research project, co-sponsored by G.E. and the U.S. Office of Naval Research, was using the 50 in.^{3} generator which Dr. Zauderer and Leo Steg, Manager of the G.E. Space Sciences Laboratory are holding in the photograph. During the next phase of the project, the 2,400 in.^{3} M.H.D. generator (foreground) will be enlarged five-fold and is expected to reach a conversion efficiency of 30 per cent.

electric current and then the potassium compounds are removed (as well as pollutants such as sulfur) and the gas, now clean, is still hot enough to drive a gas or steam turbine.

The closed-cycle method uses an ionized inert gas (helium, argon, neon), heated indirectly by coal or a nuclear reactor, and recirculated continually through the M.H.D. generator. Operating temperatures are 1,000° to 2,000° lower than in the open-cycle process, a factor which increases reliability and reduces the need for new high-temperature materials.

The bugaboo is efficiency. Eight per cent is the highest efficiency thus far obtained by open-cycle M.H.D. in a 32,000 kw. system. But now General Electric's closed-cycle M.H.D. research team, under the direction of Bert Zauderer, has broken the M.H.D. "efficiency barrier," says a G.E. press release, achieving "the long-sought 20 per cent efficiency mark." The heat generated in the shock tube (2,000° to 3,000°) was converted in G.E.'s M.H.D. generator to 1,800 kw. of electric power in 0.01 sec. bursts.

When Dr. Zauderer first started the shock-tube approach in 1961, the system's energy bursts lasted only half-a-millisecond. By 1965, a four per cent heat-to-electric conversion efficiency had been obtained in a 50 in.^{3} generator which produced 20 kw. for a millisecond. In 1968, a 1,200 in.^{3} generator produced 500 kw. at nine per cent efficiency. Improvements since then include the use of tungsten electrodes instead of copper, seeding the inert argon gas with cesium, enlarging the generator to 2,300 in.^{3}, and tripling the magnetic field strength to 27,000 gauss.

Now G.E. will build a system producing 15,000 kw. in minute-long bursts rather than the split-seconds achieved during the initial research. The generator size will be increased five-fold, and the heat source will be coal instead of a shock tube. The temperature of the inert gas will be raised to 3,000° and Dr. Zauderer expects that the efficiency of this machine will be 30 per cent, compared to the recent milestone of 20 per cent. A goal of minute-long bursts of energy is to be attained within the next three or four years, he says, and pilot plant construction will then begin.

The efficiency of M.H.D. systems increases automatically with size, and G.E. believes that its technology is advanced enough to allow construction of a 100 Mw. demonstration system by 1980. The hope is that power plants of the future, using an M.H.D. system in conjunction with conventional turbine generators, may approach 60 per cent overall plant efficiency compared to today's 40 per cent.—*M.L.*

The Villain in Coal

When fossil fuel containing sulfur is burned, the sulfur combines with oxygen and emerges with the stack gases as sulfur dioxide (SO_2). Though the effects of atmospheric SO_2 are not fully understood, there has been evidence of harm to humans and plants; hence limitations on the use of high-sulfur coal and oil designed to limit atmospheric SO_2 concentrations to 80 μg./m.^{3}.

But SO_2 may not be the chief villain.

In the presence of oxygen, sulfur dioxide slowly oxidizes into one of the acid sulfates, SO_3; then with moisture in the air (or in your lungs) to sulfuric acid (H_2SO_4). It now appears likely that much of the sulfur emitted from fossil fuel combustion ends up in the atmosphere in this form. Indeed, new data from the Environmental Protection Agency—still unpublished—shows that acid sulfates are widely distributed in the U.S. atmosphere—in the range from 7 to 13 μg./m.^{3} in the midwest and south, more than that in the areas roughly east of the Mississippi and north of the Ohio River. An average contamination of the order of 20 μg./m.^{3} is found in the northeast urban areas, covering such population centers as Pittsburgh and the Philadelphia-New York-Boston corridor.

Acid sulfates are corrosive to human tissue, and regression analyses—also still unpublished—seem unequivocally to correlate atmospheric acid sulfate concentrations with human heart and lung disorders. An increase of 15 to 20 per cent in hospital admissions of elderly people and others suffering from chronic heart or lung disorders may be attributed to acid sulfates in the 20 μg./m.^{3} range. Perhaps half of today's asthma sufferers in the northeast are victims of acid sulfates, and that form of pollution may be the cause of half of today's acute lower respiratory disease

in children. An increase of sulfate concentration to 30 $\mu g./m.^3$ might be associated with 2 per cent excess mortality.

Most acid sulfate in the atmosphere results from the combustion of coal, and most of that for power generation. The new data suggests that a 1,000 Mw. coal-fired power plant using coal containing not over 0.5 per cent sulfur may be responsible for enough acid sulfates to cause 20 to 50 deaths per year. If such a plant were permitted to use coal containing 3 per cent, the sulfur (without cleaning its stack gas), the death toll would double.

And if coal becomes the basic fuel for power generation in the U.S. by 1980, as seems to be advocated by many who fear the expansion of nuclear power, acid sulfates may by then be responsible for an excess mortality of 7,000 to 20,000—perhaps even 60,000—per year. David J. Rose, Professor of Nuclear Engineering at M.I.T., credits these findings to research just completed by the E.P.A.; he reported them this fall at a meeting of the Boston Section of the American Nuclear Society.

No comparable mortalities can be postulated as by-products of nuclear power generation, thinks Professor Rose. Indeed, the Atomic Energy Commission study by Professor Norman C. Rasmussen of M.I.T. (*see October/November, pp. 14-15*) proposed an average of 0.5 fatalities per year attributable to *all* operations associated with a 1,000 Mw. nuclear plant—including the occupational hazards of mining and enriching uranium and power plant construction as well as the more exotic accidents which are postulated for nuclear plants.—*J.M.*

Raising the Heat of Solar Energy

For a "heat mirror" that reflects heat but is transparent to light, try a thin (two millionths of an inch thick—200 Å) layer of gold or silver on pyrex. It provides insulation equivalent to "several inches" of asbestos, and three scientists from Lincoln Laboratory at M.I.T. find it a convenient material from which to make a high-temperature furnace: you can look in but the heat does not slip out.

From there it's an easy step to projecting the use of such a thin layer of metal to add insulation to windows without affecting their transparency, conserving perhaps 25 per cent of the heat energy now lost from buildings.

But an even more important future application may be in solar energy collectors, according to John C. C. Fan, Thomas B. Reed, and John B. Goodenough of Lincoln.

The chief frustration of those who would use solar energy for power generation is its low temperature. Energy from the sun arrives at the upper atmosphere of the earth with a power density of only 1 $kw./m.^2$, and the density is even lower at the earth's surface. To operate with tolerable efficiencies, power generation equipment requires temperatures of well over 1000°F. And with present technology, say the Lincoln authors, it is simply not possible to collect such high-temperature heat from solar energy without concentrators whose cost is prohibitive. The use of flat-plate collectors to gather solar power for efficiently generating electricity seems very remote also.

Can a good heat mirror help? Perhaps. The efficiency of a typical solar heat collector—a black sheet with a fluid to collect and transfer its heat into storage—is limited by the fact that some of its heat is re-radiated as infrared radiation back into the atmosphere and lost. A transparent heat mirror above the collector could capture this infrared radiation, and Drs. Fan, Reed, and Goodenough are convinced from a series of theoretical calculations that a heat mirror with a thin layer of metal deposited on a pyrex base could be an important advance toward practical recovery of high-temperature heat from solar energy. —*J. M.*

How to Save Fuel in Industry

Almost half of the fuel consumed in the U. S. is used by industry, and—even considering changes based only on existing, familiar technology—there are plenty of opportunities for "large savings." After a new analysis based in thermodynamic theory, a team of engineers led by Elias P. Gyftopoulos, Ford Professor of Engineering at M.I.T., believes that fuel consumption of a major segment of industry can be reduced by as much as 30 per cent using present technology.

This saving would be enough to fuel all U.S. industrial growth projected for the rest of the 1970s.

These estimates, published this fall in a report prepared for the Ford Foundation's Energy Policy Project (*Potential Fuel Effectiveness in Industry,* Cambridge, Mass.: Ballanger Publishing Co.), are the result of a year-long study by Professor Gyftopoulos and nine associates: Joseph H. Keenan, Professor Emeritus of Mechanical Engineering at M.I.T.; Gregory D. Betsaris, Associate Professor of Chemical Engineering at Tufts University; and seven members of the staff of Thermo Electron Corp. of Waltham, Mass.: Jerry Davis, George N. Hatsopoulos, Lazaros J. Lazaridis, Gabor Miskolczy, Dean T. Morgan, Sander E. Nydick, and Thomas F. Widmer.

By far the largest use of fuel in industry (44 per cent) is to produce steam to be used for industrial processes, rather than space heating. And here is the largest potential for saving. Process steam is typically used at nearly 400°F. and a pressure of 200 $lbs./in.^2$. If industries operated their process steam plants at only slightly higher pressures and temperatures, the spent steam—with energy typical of that now on the input side of the plant—could be efficiently used to generate electricity, reducing the plant's demand for central-station power. Or as an alternative, draw the exhaust from a gas turbine whose primary purpose is to meet the plant's electric demand.

In general, perhaps 70 kw. of electric power should be obtained for every 1 million B.t.u. used per hour to raise steam required by industrial processes —a saving of about 700,000 B.t.u./hr. of fuel at central-station power plants.

Simple heat conservation is another important and neglected strategy: heat from the output side of an industrial process can be recovered and returned to provide part of the heat required on the input side.

Here are some examples of how these two strategies could save energy in particular industries:

—Collecting and reusing heat now considered surplus in various iron- and steel-making processes could cut fuel consumption per ton of steel from today's 26.5 to 17.2 million B.t.u.s. Widespread adoption of the continuous casting process would alone save between 1 and 1.5 million B.t.u.s per ton of steel.

—Some 14 per cent of the fuel used by oil refineries could be saved if waste heat were used to generate electricity or otherwise returned to the process.

—Papermaking is energy-intensive; it represents at least 8 per cent of all industrial fuel consumption. New techniques to recover heat and reduce the amount of water required in papermaking could reduce the paper industry's use of fuel by 40 per cent and its total consumption of energy by some 75 per cent. Indeed, a paper mill using its waste heat efficiently could produce more electricity than it needed, thus becoming a producer of electricity as well as of paper.

—In 1968 fuel consumption in aluminum plants per ton of output was 155 million B.t.u.s. By 1980, if aluminum mills realized all the foreseeable with existing technology, that figure could be 106 million B.t.u.s per ton.—*J.M.*

Space Food

Nutrition is one of the inexact sciences, and its lack of precision—though easily overlooked in everyday life—was a center of frustration for those planning food for the astronauts of Apollo and Skylab. The result was N.A.S.A.'s determination to quantify the nutritional value and purity of food with greater accuracy than ever before—an achievement which may in fact have more far-reaching implications than those anticipated by N.A.S.A. nutritionists.

When a scientist accustomed to the precision of space flight comes to consider food and nutrition, he throws up his hands: "Food systems consist of a group of poorly defined components that can be infinitely variable," designed to support physiological and psychological systems which are equally ill defined.

Hence the major effort by nutritionists concerned with the Apollo and (especially) the Skylab flights to understand the astronauts' metabolic systems before, during, and after flight.

Microbiological purity was of special concern to the three N.A.S.A. scientists having principal roles in developing and managing food for U.S. space missions—Norman D. Heidelbaugh, Chief of Food Science; Paul C. Rambaut, Chief of Nutrition; and Malcolm C. Smith, Jr., Chief of the Food and Nutrition Branch, all at N.A.S.A.'s Lyndon B. Johnson Space Center in Houston. Foods could be stored at very cold temperatures, but at the Skylab's atmospheric pressure (approximately 0.3 atm.) boiling would occur at 72°F. and sterilization was impossible. All foods were therefore processed and packed in one of Houston's cleanest "clean rooms."

One result of the Skylab research, said Dr. Rambaut: "We can for the first time speak with confidence about the medical consequences and nutritional significance of weightless flight." His report, in a nutshell: No problems with ingesting food in the weightlessness of space, and no problem eliminating its products. Astronauts tended to lose weight during flights, and the "guarded conclusion" is that they used more energy in the weightless atmosphere, not less as had been expected. Both nitrogen and calcium were lost by the astronauts at rates similar to those experienced by patients on bedrest. There were "slight" decreases in limb volume and strength. Indeed, said Dr. Rambaut, "the best analogue of long-term weightlessness, at least as far as the musculoskeletal system is concerned, is absolute bedrest."

Can man endure indefinite exposure to weightless flight? No; slow deterioration of muscle and bone strength will apparently become serious after about 150 days. But long-term space travel is not necessarily impossible, said Dr. Smith: "A new era of space medicine is swiftly achieving maturity—the development of countermeasures to the deteriorative effects of weightless flight." And these results may also be applicable to terrestrial problems of human wastage, Dr. Smith promised.

What does space food imply for the future? No new products, no easy meals in tubes. But the experience of Apollo and Skylab is a glimpse of the future for food quality, reliability, and safety, thinks Dr. Heidelbaugh.

More important, however, is the notion of food engineering—the creation of a food material to meet certain critical requirements from certain available resources. The ultimate test of this concept during Skylab came when the third Skylab mission was extended from 54 to 86 days, and the N.A.S.A.'s food and nutrition experts had two weeks in which to design a supplementary food product (a food bar, as it turned out) which would feed the astronauts during their 28 unexpected days aloft without interfering with the planned psychological experiments.

In a time of critical shortage, would similar food engineering help the U.S. stretch its food resources?—*J.M.*

The Self-Immunity of Microorganisms

Many microorganisms produce potent compounds known as antibiotics which in turn have a deadly effect on a wide range of microorganisms.

Why, then, aren't the microorganisms producing antibiotics themselves poisoned by their own product?

Arnold L. Demain, Professor of Industrial Microbiology at M.I.T., focuses on this paradox in the May, 1974, issue of the *Annals of the New York Academy of Sciences.* "Antibiotics are among the most potent compounds made by living organisms," he writes. Yet producing strains can "remain metabolically active and viable in high concentrations of antibiotic."

A more puzzling paradox: "When a producing strain is innoculated into a fresh medium that contains a lower concentration of antibiotic, adverse effects on growth are observed."

Dr. Demain suspects that the key has to do with the fact that antibiotics are usually synthesized by microorganisms only after they have passed through part or all of their growth phase—the enzymes for antibiotic production are not even synthesized until growth slows down. Here are some speculations on the mechanisms involved:

—Antibiotic-producing microbes are found to contain enzymes which can modify the antibiotic, rendering it harmless. These "good housekeeping" enzymes may be synthesized in partnership with those which are required for antibiotic production.

—Membranes of antibiotic-producing microorganisms are apparently less permeable than the membranes of immature microorganisms still in the growth stage; the mature membrane protects the organism from the dangerous antibiotic it is producing.

—A feedback mechanism may be involved, shutting off the production of antibiotic when antibiotic levels grow too high in the microorganism's environment. Dr. Demain cites one experiment on a microbe that produces as much as 300 μg. of antibiotic per ml. when in full production, after its growth phase. However, if even 5 μg./ml. of antibiotic are added during the growth phase, the microbe never enters antibiotic production at all.

A still larger question: Why do microorganisms produce antibiotics at all? Perhaps they are a part of the process by which the organisms produce spores for reproduction. Perhaps a matter of self-defense, by which one microorganism maintains its integrity and living space against intruders. Or perhaps some very much less obvious explanation is necessary, involving the chemistry of microorganism growth and development.—*D.M., J.M.*

The Need to Study and Save

A "materials crisis" of the proportions of the "energy crisis" of 1974 is unlikely, if only because materials are diverse in substance, source, and use. But careful management and conservation are essential—and will be more essential in the future as raw materials become scarcer and inequities between "have" and "have not" nations more pronounced. Hence the call for a cabinet-level U.S. Department of Materials from conferees at "Henniker-3," the third materials forum to be sponsored by the Engineering Foundation on the campus of New England College, Henniker, N.H.

"Henniker-1" (1970) stimulated the work of the National Commission on Materials Policy (*see* Technology Review *for February, 1974, pp. 67-69*); "Henniker-2" (1972) contributed many recommendations to the Mansfield-Scott bill for a national "watchdog" materials commission. So Emilio Q.

Daddario, Director of the Office of Technology Assessment told the 90 "Henniker-3" conferees in August, 1974, that he hoped their recommendations could help Congress understand the issues and vote intelligently on more than 100 materials-related bills now in the hopper.

There emerged from "Henniker-3" no monolithic plan. In general, delegates were anxious to let the free market be the driving force for minimizing problems of materials resource shortages. The government's role should be in the fields of coordination, setting guidelines, and collecting, analyzing, and disseminating information. Assistance—not direct intervention—was everyone's preference.

The proposal for a Department of Materials was consistent with this choice: it would be involved with better understanding of materials information which is now scattered throughout the public and private sectors—the extent of the raw materials bases, scientific and engineering data on materials and their uses, and the production, consumption, and re-use of materials by society.

Conservation and recycling were persistent themes. They would be principal goals of the proposed new Department, which would recommend use of the government's regulatory, taxing, and related options "for internalizing of external (social) costs to ensure proper interaction of materials utilization and design practice with the goals of environment, health, safety, etc."

Universities should change their courses and curricula in engineering in order to prepare a "new generation and breed" of design, product, and materials engineers inculcated with the conservation ethic as a design parameter. There should be government incentives for materials-saving technology and practices, and government-sponsored disincentives to recycling (freight and tax rate discrimination, for example) should end. And there should be an International Materials Conservation Year, similar in scope to the immensely successful International Geophysical Year of the 1950s, to stimulate data collection, public education, and the achievement of "a national and international conservation ethic."—*Arthur H. Purcell*

Magnetic Cleaning for Coal, Water, Ore

Much of America's coal could be made far more valuable by the discovery of a simple process for removing the sulfur minerals it contains—minerals which, upon combustion of the coal, yield offensive sulfate pollutants (*see "The Villain in Coal," pp. 58-59*). Economical chemical means for removing the sulfur from the fuel or the sulfur dioxide from the stack gas have proved elusive. How about a mechanical method—magnetic, for example?

Sulfur and its mineral compounds are not magnetic—at least not in the same sense as iron and its compounds. But many of the sulfides are paramagnetic—slightly magnetic—with susceptibilities of 0.3 to 120 $\times$ 10^6 c.g.s. units, compared with 0.4 to 0.8 $\times$ 10^6 for the organic material (the fuel itself) in coal and for iron. A strong enough magnet in a sensitive separation system might indeed capitalize on the difference between the organic materials and many of the inorganic sulfides in coal.

Such a separator has now been built and tested in the Francis Bitter National Magnet Laboratory at M.I.T. The laboratory apparatus has successfully removed up to 60 percent of the sulfur and 20 per cent of the other mineral impurities from coal, and Sergio T. Trindade and Henry H. Kolm conclude that a large-scale magnetic separator might successfully desulfurize coal high in pyritic sulfur for no more than $1 per ton. This approach, they think, would be in fact "competitive for certain coals." And the system would work even better if research now in progress yields a method for making the sulfur compounds in coal more magnetic than they are now—perhaps by a chemical reaction or by selective absorption of magnetic materials by the sulfides.

The magnetic separation systems at the Bitter National Magnet Laboratory are based on very strong external fields magnetizing a filter of steel wool in which the separation takes place. In the case of coal, a slurry mixture of finely powdered full (maximum size, 50 microns) in water was passed through a filtering drum whose volume was 1 to 13 per cent occupied by stainless steel wool, the whole mass located in the bore of a large solenoid magnet.

In a commercial installation the steel wool would be in a continuous, moving matrix so that part of the filter, outside of the magnetic field, would be washed of its separated waste products while other parts of the filter would remain in the slurry stream. A similar system is envisioned by M.I.T.'s Dr. Kolm and his associates in the National Magnet Laboratory for separating unwanted waste from magnetic ore particles in mineral beneficiation and for purifying water of solids and even of dissolved organic pollutants—the latter depending upon the organics' affinity for paramagnetic aluminum ions.—*J.M.*

Put Wet Books in a Microwave Oven

Microwave ovens are familiar enough in the food industry—and even in many home kitchens. But how about in libraries and museums?

Nothing incongruous here, thinks James M. Flink, Assistant Professor of Food Processing at M.I.T. Studies in which he and Denise Thomas (now at the Winterthur Program on the Conservation of Artistic and Historic Objects at the University of Delaware) used a microwave drying oven designed for food processing suggest that dielectric heating may be "an efficient and practical method for rapidly drying wet papers," particularly of interest in treating water-soaked books and manuscripts.

Several advantages for this unconventional drying system:

—Heat is generated from within, and thus high temperatures are not needed; Professor Flink and Ms. Thomas ran their M.I.T. experiments in a 2,000-watt microwave drier with air temperatures of 20° to 25° C., and the drying, moist paper reached only 80° to 90° C.

—Wet books are often frozen from mold until they can be treated; frozen water-soaked books can be dried immediately—no thawing required—in the microwave system.

—Microwaves generate heat in areas of highest dielectric constant—that is, in the case of paper, where water is in highest concentration.

—Exposures of only a few minutes, with pages being fanned open between one-minute microwave treatments, sufficed for drying many water-soaked books in the M.I.T. tests.

Professor Flink and Ms. Thomas admit that technical problems remain. Microwave drying equipment is expensive, and control is critical. When overexposed to microwave energy, books become overdry, temperatures quickly rise to 130° to 160° C., and charring begins. So microwave drying looks especially promising for books which are uniformly soaked and for preliminary drying, making soaked books dry enough to be safely handled and fully dried in more conventional equipment.

Control would be easier, they say, if the amount of water in a book could be known accurately; will future librarians list dry weight among the critical characteristics of their priceless rarities?—*J.M.*

Beginning the First Annual Problem

Puzzle Corner
by
Allan J. Gottlieb

Rugby season is over, and I survived. I lost two toenails and sustained a couple of annoying muscle pulls—but all in all escaped essentially unscathed.

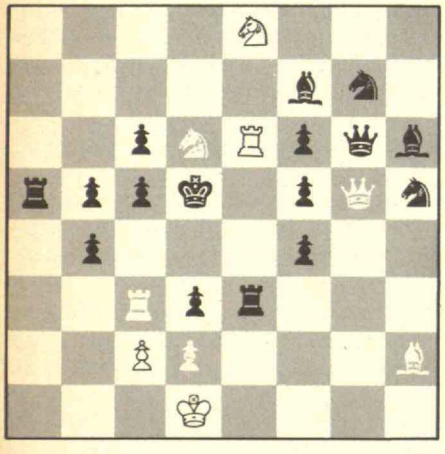
As promised a few issues ago, I shall follow the suggestion of Roger Lustig and institute a yearly problem based on **PERM 1.** This problem will run the entire year of 1975 (reprinted in later issues), and the best answers will be published next January; here goes:

Y1975 From the four digits 1, 9, 7, and 5, construct integers from 1 to 100 (none higher will be published) using *only* the following symbols:
+, −, °, /, °°, (, and).
°° denotes exponentiation (and is easy to typeset). Digits may be juxtaposed, and the best answer for a given number is the one with the lowest "point value." One point is given for each occurrence of +, −, °, /, or °°. For example, $1 = 1°°975$ gets one point; $2 = -1 - 9 + 7 + 5$ gets four points; and $2 = 7 + 5 - 1 - 9$ gets three points. Thus the third example is better than the second even though the digits are out of order. Remember that solutions above 100 or using any other symbols will not be printed.

Problems

We start this month with a chess problem (chess problems, by the way, are in short supply) from Harry Nelson:

JAN1 White to play to win:



JAN2 Les Servi wants you to prove that among triangles of a given perimeter the equilateral has maximal area.

JAN3 A very interesting astronomy problem has come from a reader whose identity has been lost (apologies!): We have seen Kohoutek as a nearly parabolic comet. What is the maximum time a truly parabolic comet can remain inside the earth's orbit?

JAN4 Paul de Vegvar would like you to find all x such that $x^x = i$.

JAN5 Frank Rubin wonders if it is possible to have a magic square with each entry prime. Can you make each entry a distinct prime?

Speed Problems

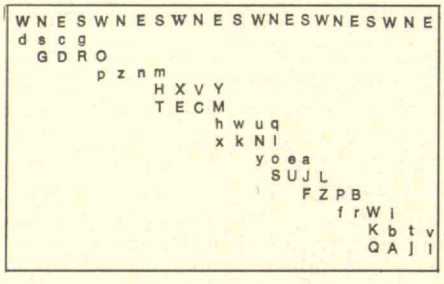
SD1 Here is a bio problem from J. Keilin: Assume an amoeba reproduces itself every three minutes. If a jar having one amoeba is filled with them in an hour, how long would it take starting with two amoebas?

SD2 The following is from Mary Lindenberg: A game is played by three men with the understanding that the loser is to double the money of the other two. After three games, each has lost just once, and each has $24. How much did each man have at the start of the game?

Solutions

The following are solutions to problems published in the July/August, 1974, issue:

J/A1 A scrambled sequence of letters is formed by choosing a keyword (containing no repeated letters) and writing the remainder of the alphabet in order after it. The letters of this sequence are written as capitals on the 26 cards ♠A to ♥2. The letters of another sequence (based on a different keyword) are written as small letters on the 26 cards ♦A to ♣2. A bridge game, contract 4♥ by S., down one, might be written as shown below.



What are the keywords?

The following is from Winslow H. Hartford:

	A	K	Q	J	10	9	8	7	6	5	4	3	2
♠	*A*	*M*	*O*	*R*	*T*	*I*	*Z*	*E*	B	E	D	F	G
♥	H	J	K	L	N	P	Q	S	U	V	W	X	Y
♦	*s*	*o*	*b*	*r*	*i*	*e*	*t*	*y*	a	c	d	f	g
♣	h	j	k	l	m	n	p	q	u	v	w	x	z

The keywords are in italics. The original holdings were:

	♠ 5 2 ♥ 9 7 5 ♦ A K 8 3 ♣ K J 7 2	
♠ A Q 8 7 ♥ J 10 3 ♦ Q 10 7 4 ♣ 8 6		♠ K 9 6 4 ♥ 6 2 ♦ J 9 5 ♣ A 9 5 3
	♠ J 10 3 ♥ A K Q 8 4 ♦ 6 2 ♣ Q 10 4	

Also solved by Eric Jamin, R. Robinson Rowe, and the proposer, Walter F. Penny.

J/A2 For positive x, let $y_1 = x$, $y_2 = x^x$, and in general $y_n = x^{y_{n-1}}$. Now let $Z_n = \lim_{x \to 0} y_n$. In terms of n, what is Z_n?

Donald Aucamp answers that $Z_n = 0$ for n odd and $Z_n = 1$ for n even. His proof involves the axiom of induction. Trivially, $Z_1 = 0$.

$Z_2 = \lim_{x \to 0+} y_2 = \lim_{x \to 0+} x^x \lim_{x \to 0+} e^{x \ln(x)} = 1$

The above result follows from the fact that, for $t = -\ln(x)$, $\lim_{x \to 0+} x \ln(x) = \lim_{t \to \infty} -te^{-t} = 0$. Now, for sufficiently small x, $y_2 = 1 + x \ln(x) + 0_2 \geq 1 + 2x \ln(x)$, where 0_2 is second order in $x \ln(x)$. This is true since, for small x, $0_2 \geq 0$ and $x \ln(x) < 0$. In invoking the axiom of induction, we assume $Z_{2n-1} = 0$, $Z_{2n} = 1$, and $y_{2n} \geq 1 + 2x \ln(x)$ for small x. These assumptions have been shown above to be valid for $n = 1$. If $Z_{2n+1} = 0$, $Z_{2n+2} = 1$, and $y_{2n+2} \geq 1 + 2x \ln(x)$, the proof is complete by induction.

$Z_{2n+1} = \lim_{x \to 0+} x^{y_{2n}} = (0)^{(1)} = 0$

$y_{2n+2} = x^{(xy_{2n})}$

$\ln y_{2n+2} = x^{y_{2n}} \ln(x)$.

Since $x^A \geq x^B$ when $0 < A < B$ for $0 \leq x \leq 1$, then $x^{1+2x \ln(x)} \geq x^{y_{2n}}$ and $x^{1+2x \ln(x)} \leq x^{y_{2n}} \ln(x) = \ln y_{2n+2}$. Thus, since $x \ln(x) \to 0$ and x^A is bounded by [0, 1] for $0 \leq x \leq 1$ for all A,

$\lim_{x \to 0+} \ln y_{2n+2} \geq \lim_{x \to 0+} x^{1+2x \ln(x)} \ln(x)$

$= \lim_{x \to 0+} x \ln(x)\, x^{2x \ln(x)} = 0$. Thus

$Z_{2n+2} \lim_{x \to 0+} e^{\ln y_{2n+2}} = e^0 = 1$. We now conclude the proof by showing $y_{2n+2} \geq 1 + 2x \ln(x)$ for x sufficiently small. $x^{y_{2n-1}} \leq 1 < 2$. Thus $x^{y_{2n}} \leq 2x$. Thus $x^{y_{2n}} \ln(x) \geq 2x \ln(x) \geq \ln(1 + 2x \ln x)$. Thus, $e^{x^{y_{2n}} \ln x} \geq e^{\ln(1+2x \ln x)} = 1 + 2x \ln(x)$. But

$e^{x^{y_{2n}} \ln x} = e^{\ln x^{x^{y_{2n}}}} = x^{x^{y_{2n}}} = y_{2n+2}$.

Therefore, $y_{2n+2} \geq 1 + 2x \ln(x)$, and the proof is complete.

Also solved by Joseph Horton, Eric Jamin, John Prussing, R. Robinson Rowe, Frank Rubin and the proposer, Neil Judell.

J/A3 What is the probability of a successful blood transfusion (one in which no adverse reaction occurred among major factors)? You need to know:

		Donor			
	Type	**A**	**O**	**B**	**AB**
Recip-	**A**	ok	ok	x	x
ient	**O**	x	ok	x	x
	B	x	ok	ok	x
	AB	ok	ok	ok	ok

	Donor		
	rh	**+**	**−**
Recip-	+	ok	ok
ient	−	x	ok

The distribution of blood types in the population is approximately as follows: A—40 per cent, O—40 per cent, B—15 per cent; and AB—5 per cent; rh+ —85 per cent; and rh− —15 per cent. Types and rh's are randomly mixed—that is, 85 per cent of each type is rh+ and 15 per cent is rh−.

The following is from Jim Toker: The first step in solving this problem is to calculate the percentage of people having each combination of rh factor and blood type:

		rh factor	
		+	**−**
Blood	**O**	34	6
type	**A**	34	6
	B	12.75	2.25
	AB	4.25	0.75

Next, set up a table of all the various combinations of donor and recipient blood types, and eliminate those combinations in which the transfusion fails (top of cols. 2-3). Then, using the percentages from the first table, calculate the probability of occurrence for each of the remaining combinations. Finally, add up the probabilities of each successful transfusion to obtain the solution—that the probability of having a successful transfusion is 53.440625 per cent.

		Donor							
	Type	**O**		**A**		**B**		**AB**	
	rh	+	−	+	−	+	−	+	−
	+	11.56	2.04	x	x	x	x	x	x
	O −	x	0.36	x	x	x	x	x	x
	+	11.56	2.04	11.56	2.04	x	x	x	x
	A −	x	0.36	x	0.36	x	x	x	x
Recip-	+	4.335	0.756	x	x	1.62-5625	0.28-6875	x	x
ient	**B** −	x	0.135	x	x	x	0.05-0625	x	x
	+	1.445	0.255	1.445	0.255	0.54-1875	0.09-5625	0.18-0625	0.03-1875
	AB −	x	0.045	x	0.045	x	0.01-6875	x	0.00-5625

Also solved by Winslow Hartford, Neil Hopkins, Eric Jamin, R. Robinson Rowe, Frank Rubin, Harry Zaremba, and the proposer, Joseph Horton.

J/A4 A standard deck of 52 cards is shuffled and placed face down upon the table. The cards are then turned face up one at a time by flipping over the top card of the face-down stack. As this is done, the player simultaneously calls out the sequence A, 2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A, 2, etc., one call being made for each card flipped over. To win the game, one must go through the deck without matching a card flipped over with the card called. Suits do not matter; for example, any four-spot flipped over on the 4th, 17th, 30th, or 43rd turn results in a loss. What are the chances of winning the game? How about a second solution for the same game with a 48-card pinochle deck?

For this one everyone gave approximations; the following is from Harry Zaremba: The derivation and manual computation of an exact solution would be a formidable task. However, a good approximate answer is given by the formula:

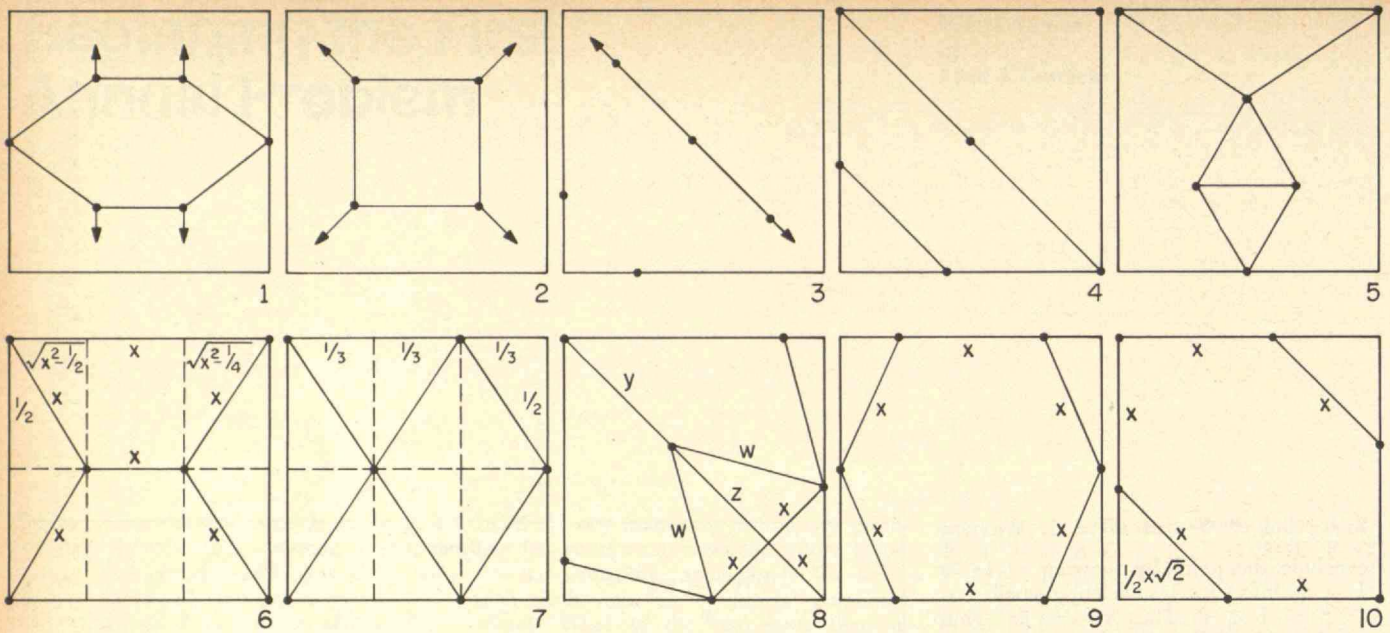
$$P_o = e^{-k}\left[1 - \frac{k(k-1)}{2(n-1)} + \frac{k(k-1)(3k^2 - 11k + 16)}{24n(n-1)}\right.$$

where P_o is the probability of the event that no card matches a call, n is the number of cards in the deck, and k is the number of identical cards in each of m different sets of cards in the deck in which the suits are ignored (n = mk). Thus, for a 52-card deck, n = 52, m = 13, and k = 4; therefore $P_o = 0.0162299$, or about one chance in 62 trials that the game could be won. In a 48-card pinochle deck, n = 48, m = 6, and k = 8; $P_o = 0.0001772479$, or one chance in approximately 5,642 trials for a game to be won. Generally, when n and $m \to \infty$, P_o approaches e^{-k}. I have computed an exact probability value for n = 12, m = 3, and k = 4, which is $P_o = 0.00998557$. The formula yields $P_o = 0.0097128$, which is a fair approximation even for a low magnitude of n.

Also solved by Neil Cohen, Winslow Hartford, Neil Hopkins, Joseph Horton, Eric Jamin, Judith Q. Longyear, Jack Parsons, Craig Presson, R. Robinson Rowe, and Frank Rubin.

J/A5 Place six points inside a unit square so that the nearest two are as far apart as possible.

The only proof supplied is from the proposer, Frank Rubin, whose solution follows: Like many innocent-looking problems, this one has hidden teeth. Clearly, at least three of the points must be on the boundary or we could simply spread the remainder apart (Figs. 1 and 2 at the top of the next page). Assume three interior points; if they are in a line (Fig. 3), the farthest they can be separated is along the diagonal (Fig. 4). This configuration obviously cannot be better than that of Fig. 10. If the three interior points



form a triangle, the best configuration is shown in Fig. 5. Clearly this cannot be better than Fig. 7. So assume two interior points. The only reasonable configuration seems to be that of Fig. 6. Here $x + 2\sqrt{x^2 - .25} = 1$, so $x = (\sqrt{7} - 1)/3 = 0.5485$. Next, assume one interior point. There are two reasonable configurations, Figs. 7 and 8. In Fig. 7, $x = \sqrt{1/4 + 1/9} = \sqrt{13}/6 = 0.6009$. In Fig. 8 we can show that the minimum distance is less than 0.6; for if $x \geq 0.3$ and $y \geq 0.6$, then Z can be at most $\sqrt{2} - 0.9 = 0.514$, so $w \leq \sqrt{0.514^2 + 0.3^2} = \sqrt{0.352}$, which is less than 0.6. Finally, consider the possibility of no interior points whatever. The reasonable configurations are Figs. 9 and 10. Fig. 9 obviously has x the same as Fig. 6, namely $x = 0.5485$. In Fig. 10 we have $x + \frac{1}{2} \cdot \sqrt{2} = 1$, $x = 2 - \sqrt{2} = 0.5858$. The optimal configuration is therefore Fig. 7, with $x = 0.600925$.

Responses were also received from Walter Daugherity, Joseph Horton, Eric Jamin, Winslow Hartford, and Harry Zaremba.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973) he is now Assistant Professor of Mathematics at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y. 11432.

Letters

Continued from p. 4

while, manure from feed lots has become a major solid waste disposal problem. Granted that manure (and much compost) is deficient in valuable trace minerals, modest applications of lime, bone meal, wood ashes, or powdered rock will usually correct the balance. The wise organic farmer tests the soil and develops its fertility over a period of years.
William F. Hoey
Hamden, Conn.

Saving Energy: Apples vs. Oranges, and Consider the Lowly Motorcycle

The chart accompanying your report on "Conserving Transport Energy" (*"Trend of Affairs," June, pp. 54-55*) indicates that converting to 50 per cent small cars would result in energy savings of 9 per cent and converting 50 per cent of cars to 30 per cent better mileage would result in savings of 10.25 per cent. The Department of Transportation says the average mileage now is 13 m.p.g.; a 30 per-cent improvement would be 17 m.p.g. Assuming a random distribution in both conversions, I find it hard to believe that you believe that 17 m.p.g. is saving more than 22 m.p.g.

The 1 to 2 per cent savings by walking is almost insignificant—except that it represents close to 100,000 bbl./day of oil, or the entire output of a fair-size refinery. It also represents the mentality of the designers and engineers who have locked the U.S.A. into an inflexible system that cannot be changed except by tremendous capital expenditures over several generations.
Charles Donaho
Houston, Texas

Since the article listed the assumptions Dr. Malliaris used, I proceeded to check the calculation that led to his estimate that a 50 per-cent conversion to small cars will produce fuel savings of only 9 per cent. He assumed that 90 per cent of today's cars get 13.1 m.p.g. and 10 per cent (the small cars) get 22 m.p.g. He then assumed an increase in the small car population to 50 per cent. My numbers, based on a 100-mile trip, are as follows: Present situation—50 miles at 13.1 m.p.g. = 3.82 gal. and 50 miles at 22 m.p.g. = 2.27 gal. for a total of 6.09 gal. or 17 per cent less than before.

Dr. Malliaris makes no mention of motorcycle use in urban situations to conserve fuel. Small motorcycles have been ignored for too long as fuel-saving possibilities. I propose that, instead of converting 50 per cent of the vehicle population to small cars, we convert 50 per cent to small motorcycles averaging, say, 75 m.p.g. Assume the motorcycles are used only two-thirds of the time—allowing for rain and cold weather. The remaining vehicle population could be 10 per cent large cars at 13.1 m.p.g. and 40 per cent small cars at 25 m.p.g. Thus, two-thirds of the time, with 50 per cent motorcycles, 40 per cent small cars, and 10 per cent large cars, we need 3.03 gal.; one-third of the time, with 80 per cent small cars and 20 per cent large cars, we need 4.73 gal., for an average of 3.6 gal. or a savings of 51 per cent.

Some may consider my estimates a bit too optimistic. But the point is that there is a vast potential for fuel savings in the urban situation without requiring substantial changes in life styles.
D. Thomas Terwilliger
Lafayette, Ind.

Dr. A. C. Malliaris of the Transportation Systems Center, Cambridge, whose report was summarized in Technology Review, *clarifies our report as follows:*

If one wishes to avoid comparing apples with oranges, then the conservation potential of each individual action must be determined as a percentage of the total transportation energy. . . . I repeat here two elementary calculations for the benefit of the above and any other unhappy readers: To convert 50 per cent of the passenger car population to small cars (22 m.p.g.) we convert from a population in which 90 per cent of the cars achieve 13.1 m.p.g. and 10 per cent achieve 22 m.p.g. (an average of 13.65 m.p.g.) to one in which half the cars achieve 13.1 m.p.g. and half 22 m.p.g. (an average of 16.42 m.p.g.) This is a 16.9 per cent reduction in the fuel consumption of passenger cars, or a reduction of 9 per cent in the total of transportation energy, since passenger cars account for about 53.5 per cent of the total transportation energy.

Consider now the next action: introduce in 50 per cent of highway vehicles a 30 per cent reduction in fuel consumption. Highway vehicles include not only passenger cars but also trucks, buses, etc.; together these vehicles account for 76.5 per cent of the total transportation energy. Obviously, the action under consideration here would yield 50 per cent × 30 per

cent × 76.5 per cent, or about 11.5 per cent energy savings considering the whole transportation sector. This is higher than the 9 per cent savings determined in connection with the previous action.

Your readers should keep in mind that all this arithmetic is based on 1970 statistics, the latest available when the original material was prepared. Please also consider that the views expressed in the original material are those of the authors and do not necessarily represent the policies or positions of the U.S. Department of Transportation.

Environmental Improvement: Regressive Tax or Valid Market?

In his June article (*"Public Markets: Growth Opportunities and Environmental Improvement," pp. 30-39*), James Brian Quinn views pollution control as a source of economic growth. But this is very much like calling influenza a "growth industry." We spend more money to cure it than we would if there were no epidemics, but we can do without that kind of economic growth.

Professor Quinn ignores an important point: The addition of pollution control equipment to unchanged productive technology reduces productivity and increases costs. It requires very large capital investment. At a time when inflation and interest rates are running at 12 percent annually, these difficulties can hardly be shrugged off by saying that the costs will be passed to the consumer with little or no drop in demand. At best, shortages of many goods will be exacerbated and higher prices will serve as a regressive sales tax with greatest impact on the poor.

This may be the price we have to pay for a tolerable environment in our society, but it hardly seems a cause for exuberance. And there are alternatives. Instead of tacking expensive filters to smokestacks, solar heat can be substituted for fossil fuels and electric power. Throughout industry, there are opportunities to replace polluting technology with inherently cleaner methods and processes. With some ingenuity, environmentally sound productive technology can be found which is also economically efficient. While we try to find ways to stimulate this kind of innovation, we may have to put up with the pollution control "growth" industry. But outside the realm of satire the costs involved should not be a matter of celebration.

Sheldon Novick
St. Louis, Mo.

Mr. Novick is Editor of Environment, *a publication of the Scientists' Institute for Public Information. Professor Quinn responds:*

I would disagree heartily with Mr. Novick that influenza is not a "growth industry." Influenza is a valid social problem. Some percentage of the population would prefer to spend its money on an influenza cure rather than undergo the inconvenience of the disease. In the process, jobs are created, values are produced, and profits are made. This does not mean that the society should stimulate influenza if the disease does not already exist. It should simply compare the benefits and costs of solving the influenza problem against the benefits and costs of satisfying its other demands, e.g., high-speed snow transportation (snowmobiles) or marginal increases in the quality of sound produced by high fidelity systems, etc. Surely, an influenza cure must rank high relative to a large number of the expenditures of our current society.

If environmental demands are recognized as valid market opportunities, presumably competitive approaches will attempt to yield the lowest cost method of satisfying these demands. Along with forced internalizing of costs, this should lead to what Mr. Novick seeks, "environmentally sound productive technology. . . which is also economically efficient." The costs involved are not a matter of celebration, nor are they a matter for doom speaking. They simply represent an intelligent response to demands placed by a society's constantly changing value system.

James Brian Quinn does not seem to penetrate down to the primary motivations behind the problem of achieving environmental improvement.

The average American does not settle in one place for long. Houses are sold on the average once every seven years. A direct consequence is that the typical American makes little emotional investment in the community; he has little feeling of caring or being proud of his home town, nearby forest preserve, or river. It is evident that such a person will not make a long-term investment in environmental conservation or improvement.

This mobility has great advantages; it is at once the cause and result of the flexibility of American economic life, which manifests itself in a standard of living that is at least double that of any other nation.

A second way in which prosperity enters this issue: Resources are still plentiful and population density is relatively low. It is not self-evident to most Americans that they cannot move on to new land after their local environment has been used up.

By creating expedient "public markets" (a monopolistic pooling of individual demand) and by vesting the management of them in the hands of a few politicians or public servants, the individual would relinquish almost all control over his or her own destiny. In all plans of utopian, futuristic social systems, it is customary to tacitly assume that politicians and public servants always act in the public interest. It is time to be realistic: Broad public understanding, trust, and support are the only necessary and sufficient conditions for resolving our environmental problems.

John Tuzson
Evanston, Ill.

Mass Transit vs. the Cost of Government

Your conclusions that the car will be with us for a long time are probably true (*see "How Can Cars Be Compatible?" July/August, pp. 54-55*); the way we have built our cities, you simply can't get from here to there in a reasonable time without a car. Another is that we use cars when alternative, more energy-efficient systems are available. How can mass-transit use be encouraged?

A paradox: We subsidize mass transit; and also always seem to be raising our government employees' pay as the cost of living goes up. Why don't we simply require the use of mass transit as a condition of employment for all government employees, and then provide free transportation to and from work for them? Think of the problems this would solve in nearly every city in the country.

Dan B. McDevitt
Tulsa, Oklahoma

The writer is President of the Research and Development Institute of the United States.—Ed.

Suicide, Homicide, and the Automobile

In *Surviving to 3000* (Belmont, Calif.: Duxbury Press, 1972), R. L. Posterman notes that there have been long-term oscillations in the homicide rate (*see "Murder Will Up," July/August, pp. 49-50*) with a peak in the 1930s and (based on very sketchy data) in 1870. His figures—which are for the entire country, rather than urban areas—show that the suicide rate is higher than the homicide rate usually by a considerable margin, and that the vehicular fatality rate is on the order of three times the homicide rate.

William Squire
Morgantown, W. Va.

The writer is Professor of Aerospace Engineering at West Virginia University.—Ed.

Materials in the Energy Crisis

Are not mineral shortages a special case of the energy crisis? Energy was required to produce the original geologic concentration of minerals. More energy was and is used to refine metals and to produce materials. Energy is required to recycle materials. Were there no energy problems minerals could be recycled from the sea. Thus is it not true that energy and materials are equivalent in an entropic sense? If so, are mathematical techniques available to quantitate this relationship?

Robert A. Wilson, M.D.
Ventura, Calif.

Electric Cars? Back to Fundamentals

Professor Pierre Aigrain may be able to pack a lot of watt-hours into his battery (*see "The Electric Car: Enter the Engineer," March/April, pp. 62-63*); but I would like him to explain how he rationalizes the fossil fuel waste inherent as the typical utility company burns four gallons of fossil fuel to provide a battery charge equivalent to one gallon of fossil fuel for his electric car.

Thomas Cerwonka
Kingston, N.Y.

Stonehenge: Practical Value?

In his review of *Beyond Stonehenge (January, 1974, pp. 68-69)*, John E. Pfeiffer comments that "we can . . . assume that then, as now, it was rather difficult to obtain substantial support for projects of no immediate practical value." I submit that there is no basis for such an assumption, and that it may be exactly contrary to fact.

First, it is not at all certain even who built Stonehenge (or the other magaliths and various "wood" henges around the world); much less do we know what kind

(*Letters continued on p. 72*)

Book Reviews

Medical Resource or Political Repression?

Brain Control
Elliot S. Valenstein
New York: John Wiley and Sons, 1973, xix+407 pp.

Reviewed by Charles G. Gross

Psychosurgery is the selective destruction of human brain tissue to alter thought and behavior. In the 1940s and 1950s it was used extensively for the treatment of mental illness; an estimated 70,000 frontal lobotomies were carried out in the United States and Great Britain alone. The number of lobotomies declined markedly with the introduction of "tranquillizing drugs" in the mid-1950s.

There has recently been a major resurgence of psychosurgery. A number of new techniques have been introduced including limited frontal lobotomies, discrete destruction of other brain areas, and electrical stimulation of the brain through implanted electrodes. Whereas the use of psychosurgery was formerly confined to traditional mental diseases, it is now also used to treat such conditions as violence and aggression, hyperactivity in children, and even homosexuality. This "new psychosurgery" has generated considerable debate. On the one hand, it has been advocated as a solution to urban violence and a humane substitute for prison for antisocial offenders; on the other hand, it has been attacked as a tool for the oppression of political activists, blacks, and women.

In this scene of charge and countercharge, accusation, and self-serving justification, Valenstein's *Brain Control: A Critical Examination of Brain Stimulation and Psychosurgery* is a sorely needed contribution. Although designed for the lay audience, *Brain Control* is in no way popularized or sensational. Rather it is the successful attempt of a distinguished and concerned brain scientist to provide the historical and scientific background "necessary for an informed discussion of the ethical and social issues" raised by psychosurgery. The book serves both as an introduction to the medical literature and as a framework for consideration of the wider legal and ethical questions.

The first part surveys the scientific background of psychosurgery. Several major themes emerge. The effects of electrical stimulation of the brain, even in rats, are shown to depend crucially on the previous experience of the animal and on the environmental context in which the stimulation occurs. Furthermore, destruction of a brain site will usually not eliminate the behavior elicited by electrical stimulation of that site. Thus, the author argues, aggressive behavior may be produced by stimulation of a particular brain structure in some situations but not in others. In any case, destruction of part of the brain is unlikely to eliminate aggression and leave the animal otherwise normal.

What's Good for the Goose

Another major theme concerns extrapolation from animal experiments to human clinical procedures. Each of the psychosurgical techniques derives directly from experiments on animals. Yet the application to man invariably involves a superficial and selective reading of the animal experiments. For example, frontal lobotomy in man was inspired by the casual observation that after a lobotomy, one chimpanzee no longer had temper tantrums when it made errors on a learning task. The main result of the surgery—namely, a major cognitive deficit—seems to have been ignored.

Similarly, one of the current techniques for treating violence in adults and hyperactivity in children originated in the observation that destruction of another brain region (the amygdala) resulted in the taming of previously wild monkeys. But this operation simultaneously produced perceptual, social, dietary, and sexual abnormalities, all of which were originally described as prominently as the "taming" effect. Of course, the absence of any scientific basis for a medical procedure does not rule out its possible therapeutic value; much of modern medicine is empirical, not rational. However, the results of the animal experiments should have made psychosurgeons more concerned with the "side-effects" of their procedure than they appear to have been.

The second portion of the book reviews the major psychosurgical techniques and the evidence for their efficacy in relieving human suffering. The results of Valenstein's survey of the major psychosurgical techniques now practiced are all too clear: There is a shocking paucity of data. Almost no adequate studies involving extensive pre- and post-operative examination by investigators not beholden to the psychosurgeon have been carried out. All too frequently, reports of brain intervention "successes" seem to be reports of "taming" the patient. It is often unclear at what cost to the patient's personality and cognitive ability this end was achieved. Not only are the results of psychosurgery difficult to ascertain; so, too, is the extent of its practice.

Psychosurgery as a Symptom

Unfortunately, *Brain Control* contains little detailed discussion of legal problems of psychosurgery, such as the concept of informed consent, the relation between treatment and experimentation on humans, and the possible role of the medical profession, the community, and government in the regulation of psychosurgery. Similarly, the sociology of psychosurgery gets relatively little attention. The advocacy of psychosurgery for ghetto rioters, militant prisoners, hyperactive children, and homosexuals seems to be part of a larger trend. Along with sterilization for the "incompetent poor," methadone addiction for heroin addicts, amphetamine medication for troublesome school children, tranquillizers for the middle class, and behavior therapy for prisoners, psychosurgery for deviates reflects an increasing attempt to deal with social problems by emphasizing manipulations of the individual rather than alterations of the social and economic conditions that contribute to the individual's problems. Although these legal and sociological issues deserve more attention than they receive, *Brain Control* is otherwise a superb and comprehensive basis for informed judgement on a complex and critical problem.

Charles G. Gross is Professor of Psychology at Princeton University.

How to Save Energy: Frustrations Remain

Potential Fuel Effectiveness in Industry, Elias P. Gyftopoulos, Lazaras J. Lazaridis, and Thomas F. Widener; Cambridge, Mass.: Ballinger Publishing Co., 1974

Reviewed by Richard Wilson

Since the Arab oil embargo of 1973-74, there has been a lot of talk about energy

conservation. But there has been a law of the conservation of energy for 100 years, and the only controversy remaining about it is how to pronounce the name of the man (Joule) who was associated with its formulation. Public use of the term "energy conservation" follows from a confusion about the thermodynamic principles of fuel utilization, particularly among the businesspeople and economists who have to apply them in practice. This book remedies this state of affairs somewhat.

Internal energy, entropy, and enthalpy are all thermodynamic functions of the system, and they remain the same, independent of the surroundings. Yet it is these surroundings which determine how much of the internal energy is available. A reservoir filled with water at 6,000 ft. above sea level has a lot of potential energy which can be used for hydroelectric power; but if this reservoir is near Denver (already 6,000 ft. high), it is clearly less useful than if it is near New York, at sea level. Gyftopolous *et al* argue that a correct calculational procedure is to return to an old paper by Gibbs (in 1875) who defined *available* useful work

$$\Phi = E + P_oV - T_oS - \sum_{1}^{n} \mu_{io}\eta_i$$

where E is the internal energy, V the volume, and S the entropy of the system; η_i the number of moles in the ith component; P_oT_o the pressure and temperature of the atmosphere, and μ_{io} the total potential of any component in the atmosphere. This then gives the maximum amount of work obtainable in any process, though this amount will rarely if ever be realized in practical terms; the energy will be used inefficiently by many irreversible processes.

Most recent writings have concentrated upon the savings in fuel which individuals can make: by switching off lights, turning down the thermostat, and so forth. Yet industry consumes *more* fuel than private individuals. These authors, after a discussion of the principles in the terms indicated above, go through examples in six industries: steel, petroleum refining, paper, aluminum, copper, and cement.

It is very useful to have as a yardstick the maximum possible work one can obtain from fuel; this could prevent much time being wasted trying to increase efficiency beyond that theoretical limit and in practice shows how much we have yet to gain. However, available useful work is a concept unfamiliar to most of us, and elementary examples, with reference to more generally familiar concepts, are needed to make it clear. The authors go through an example of obtaining work from a hydrocarbon oxidation process and identify two separate losses of available work: Fuel is burned irreversibly in a combustion chamber, losing one-third of the work; the combustion products then have a temperature of 4300° F., whereas the work is usually used at a lower temperature, and the heat transfer is irreversible. In a central steam power plant, the receiving temperature is 600° F., and only 48 per cent of the available work is left. This second loss is the reduction in efficiency of an engine as the temperature of the heat source is reduced from 4300° to 600° F. In an industrial process, the loss in available work is greater than that for electricity generation, as combustion may merely be used to generate process steam at an even lower temperature of 270° F. Thus, the authors are led to a discussion of a "topping" cycle—where an electricity generator is added to a steam-producing plant; work which would otherwise be "wasted" is produced in the form of electricity while cooling the steam from 600° F. to the desired 270° F.

This method of approach to the subject is new to me, and the description is overly complex. In thermodynamic discussions an absolute thermodynamic scale makes many arguments simpler. Why, then, stick to B.t.u. and degrees F.? At least the figures could have two scales and include joules and degrees K. I found myself trying to apply this method to a system familiar to most of us, including engineers and industrialists—home heating. Here there are two obvious types of systems we would like to compare:

—We can burn the fuel directly in the room, and extract all the heat at constant pressure from the combustion gases.

—We can produce electricity (perhaps even reversibly with a fuel cell), and use a heat pump to bring in heat from the outside.

It is not at all clear from the book how the effectiveness of these two are to be calculated. The difficulty of understanding the method is worse when it is to be applied to far less familiar industrial processes. There the amateur must rely on the formulae (which he has not yet learned to trust), and the usefulness of the industry examples is therefore impaired.

The problem in understanding is even more serious. The general method of how to extract the maximum work from available fuel is not the only, and probably not the most important, method of fuel saving in industry. For example, as the authors themselves note, improved paper forming procedures can reduce the water need in the paper, and therefore the work needed in drying it; better insulation can reduce the amount of steam required in any process. These methods are distinct from improved thermodynamic processes and demand common sense rather than detailed thermodynamic analysis. However, the distinction is not clearly made in the book, and an opportunity for increasing understanding is missed.

Thus an amateur must compare this book with other books whose conclusions he cannot deduce himself but which rest on authority (or common sense). By concentrating only on six industries, this book is less useful than the report, "Techniques of Efficient Energy Utilization" (available free from N.A.T.O. in Brussels), prepared by a N.A.T.O. science committee in 1973, where experts summarized the whole field and found a host of places where immediate gains could be made and others where research is needed. The two reports agree—where they overlap—in the feeling (which coincides with the reviewer's prejudice) that with present technology, 30 per cent of the fuel used in industry can be saved—and at a cost worthwhile with present ($11/bbl.) prices of oil.

This book cannot, therefore, be considered the definitive work for engineers and economists in industry, nor is it clear enough to be the definitive text for the neophyte. But until these books are written (and they do not seem to be on the horizon), every environmentalist who urges better fuel utilization (and what environmentalist does not?) must have it on his bookshelf.

Richard Wilson, whose field is nuclear and high-energy physics and who has recently been concerned with environmental effects of energy, is Professor of Physics at Harvard University.

Cohn

Continued from p. 8

tory job given to a new Nuclear Regulatory Commission). So there is obviously a good deal of sorting out still to be done.

At almost exactly the same time that these events occurred in October, a six-month, $5 million "Project Independence" study ordered by Sawhill and a two-year, $3.5 million Ford Foundation Energy Policy Project came to amazingly similar conclusions: The country has hardly begun to clamp down on energy waste in the many ways that it must if it is to avoid many energy disasters.

The Energy Policy Project staff and most of its consultants believed that a strong, mandatory program of energy conservation for automobile drivers, builders, and virtually all fuel users could give the country a 10-year grace period in which to better study the wisdom of such "massive new commitments" as offshore drilling, nuclear breeder reactors, and strip mining in the West for coal and shale.

Such drastic advice has not gone down well with politicians Ford and Morton. They could be thinking of a 1976 election that could put the stricken Republican party into a fatal decline.

Will it sit any better with the Democratic politicians—and Presidential aspirants—who are now in at least loose control, though in a highly unfocused way, with no clear leadership in either House? Perhaps not. The Democrats have high hopes of electing a President in 1976, and there may not be many votes in forcing people to use less fuel.

We now know there will be both Administration and Democratic fuel conservation proposals by mid-January. In December Secretary Morton finally began talking of "some awfully tough turkey," and Minnesota Democratic Senator Walter Mondale said, "The heat's on us now." As to results, we shall see.

Victor Cohn, whose reports appear regularly in this space in Technology Review, *reports on science and related issues for the* Washington Post.

Institute Informant

Continued from p. 13

Highest Cost, Highest Ratio

Anticipating "the coming shake-out in higher education," *Forbes* magazine last fall found M.I.T. offering the most expensive undergraduate education in the U.S.—and the highest student/faculty ratio.

Total charges to attend M.I.T. were listed as $5,442 a year—tuition and fees plus average room and board costs. Harvard was pegged at $5,350, Yale at $5,300, Wesleyan at $5,173, Columbia at $5,115, and Princeton at $5,045.

Only a few Ivy League schools had student/faculty ratios close to M.I.T.'s 5:1. Harvard and Princeton were posted at 6:1, Columbia, Yale, and Chicago at 7:1. "Big Ten" state universities ranged from 17:1 upwards.

Of the private universities listed by *Forbes*, M.I.T.'s operating budget was second largest—$221.2 million, compared with the University of Pennsylvania's $229 million. M.I.T. endowment was fourth largest—$440.9 million compared with Harvard's overpowering $1,200 million, Yale's $550 million, and Princeton's $532.7 million.

Arts at M.I.T.: Change In Response to Change

Is M.I.T.'s growing concern for and interest in the arts a sign that the Institute is, "like a magician's handkerchief, changing its colors before our very eyes?"

Not so, says President Jerome B. Wiesner. Yet it is not enough to say that the arts are not new at M.I.T.—that there has always been an art museum, that the Symphony Orchestra is almost as old as any university's.

"What is perhaps new," said Dr. Wiesner on the occasion of the annual meeting of the Council for the Arts at M.I.T. this winter, "is that the arts themselves have become one of the issues of the changing times.

"If society is beginning, as I believe it is, to become serious about cultural development in somewhat the same ways it has been serious about economic and social development, it will need facts and figures as the precondition of knowing how to proceed. It is precisely in this that I think and hope M.I.T. can make its particular contribution.

"If we can develop here an active, broadly based, participatory program in the arts that is solidly founded on teaching, practice, and research, we may well hope to develop some of the figures and configurations—the models of doing—that will be useful elsewhere.

"I happen to believe that the arts are in fact 'useful' knowledge and that the imagination, the mental muscle of man's spirit, atrophies if it is not used," said Dr. Wiesner. "If there is a new level of response at M.I.T.," he said, "then it is really only a new form of that same old response: change in response to change."

How to Manage Art

Art has suddenly become a management problem.

"In this kind of economy, art is the first to get cut," says Alice McHugh, Executive Director of the Metropolitan Cultural Alliance in Boston. "People in the arts are very, very uptight today," she told Susan Trausch of the *Boston Globe* last fall. "We have to think very seriously about priorities, about down-to-earth business basics."

Hence a seminar to be sponsored this winter by the Alliance (made up of 95 non-profit art organizations in Greater Boston, formed in 1972 to strengthen their financial management) at the Sloan School of Management, where John F. Rockart, Senior Lecturer, promises to "give them the solid, tried-and-true business basics."

Nothing unusual, said Dr. Rockart. "There are many programs like ours going on all over the country," he told Ms. Trausch. Indeed, he said, there is "a significant trend on the part of professionals in the arts to learn the basic tools of the management trade as well as the art."

The Sloan School's 2½-day session will touch on taxation, cash flow management, program budgeting, union negotiations, and the management of conflict within institutions. It will be "talking about survival," says Ms. McHugh.

A World-Wide Search for Energy Alternatives

Have the world's industrial nations any real options for managing their use of energy for the rest of the century? New resources? Conservation? Better efficiency? Or simply higher cost, lower growth, more inflation?

Carroll L. Wilson, who is the Mitsui Professor in Problems of Contemporary Society in the Sloan School of Management, is intrigued, for instance, to discover that per capita energy consumption varies widely between developed nations with apparently similar standards of living—Britain and the U.S., for example. Geography is a factor, of course, but there must be other differences. Does one nation have something to learn from another? Do we all, from each other?

Hence his plan, now in motion, for a two-year Workshop on Alternative Energy Strategies (W.A.E.S.), to which a distinguished international group of business and public leaders are committed. The leaders themselves will meet for several days as many times a year, and each has designated an expert from his staff to work full time with W.A.E.S. and to attend more frequent, longer meetings.

In essence, there will be from each country an assessment of energy problems and alternatives not unlike that just completed for the U.S. by the Ford Foundation's Energy Policy Project, says Professor Wilson. Then W.A.E.S. will try to bring all these together into a comprehensive plan to which all industrial nations can subscribe.

Conservation will rank high in that final plan if Professor Wilson's instincts tell him anything about the project results. Adding one barrel to oil production capacity now costs $10,000; for shale oil the cost might be $16,000. To produce comparable energy through electric power generation might involve an investment of $100,000. "These are the kinds of numbers that have led me to think of the advantages of savings," he told Robert Cooke of the *Boston Globe* in the fall.

But even energy conservation will be accomplished by different strategies in different countries, Professor Wilson told a Sloan School alumni convocation last fall. Japan has few alternatives; France has set an absolute ceiling on foreign energy expenditures; Norway will develop its own resources at its own pace. What of the U.S.? Other countries?

W.A.E.S.' first meeting took place in September. Among the delegates, each of whom brought an associate who will work full time for W.A.E.S. studies:

Thornton F. Bradshaw, President of Atlantic Richfield Co.
Walker L. Cisler, Chairman of Detroit Edison Co.
John T. Connor, Chairman of Allied Chemical Corp.
Jean Couture, Conseiller du President, Société Générale (France)
Marshall Crowe, Chairman of the National Energy Board (Canada)
J. C. Davidson, Director of Shell International Petroleum (U.K.)
Khodadad Farmanfarmaian, Chairman of the Bank Sanaye (Iran)
Richard C. Gerstenberg, Chairman of General Motors Corp.
Shuzo Inaba, Commissioner of the Atomic Energy Commission (Japan)
Saburo Okita, Chairman of the Japan Economic Research Center
Masao Sakisaka, President of the Institute of Energy Economics (Japan)
Christian Sommerfelt, Chairman of Elkem-Spigerverket A/S (Norway)
H. Guyford Stever, Director of the National Science Foundation
A. A. T. Van Rhijn, Deputy Director General for Energy of the Ministry of Economic Affairs (the Netherlands)
Erland Waldenstrom, Chairman of Granges AB (Sweden)

Every Career Is Anchored to a Theme

Thirteen years ago Edgar H. Schein, Professor of Organizational Psychology and Management, asked 44 graduate students just finishing their work in the Sloan School of Management why they wanted to be managers and what they hoped to accomplish in their careers. Now, with these graduates in mid-career, Professor Schein has brought them back to M.I.T. and asked the same questions all over again.

As a result, Professor Schein identified five "career anchors"—common themes in what people are fundamentally looking for in their careers—and he can identify each student in the group with one such theme, an "unchanging personal motivational/attitudinal/value syndrome."

The five are:

—Managerial competence, a fundamental motivation "to be competent in the complex set of activities which make up the idea of 'management'." The important components are "interpersonal competence," "analytical competence," and "emotional stability."

—Technical-functional competence, a basic concern for excellence in a particular technical field or functional area—financial analysis, marketing, systems analysis, corporate planning, or whatever.

—Security, an orientation which is manifest in managers who have tied their careers to particular firms or institutions and accept "organizational definitions" of their career paths.

—Creativity, the basic need of a person to "create something new which can be clearly identified with him," says Professor Schein. It is "the fundamental need operating in the entrepreneur," he says.

—Autonomy and independence, goals which often move people into consulting careers or out of business entirely.

Of the 44 Sloan School graduates, about one-fifth are anchored in managerial competence, nearly half in technical-functional competence. For the latter there are frustrations and uncertainties; many of them, says Professor Schein, have a sense of "violating the 'success ethic' of the business world" because of their devotion to a field instead of to advancement per se.

Four of the group are in the "security" classification, seven have opted for autonomy (their academic records in both undergraduate and graduate work were highest of all), and five—"the most interesting group"—are the creative entrepreneurs. They had the lowest college grades, but four of them have already launched successful enterprises and one is a marketing consultant whose principal motivation is to find new enterprises to develop.

Formal titles and career paths tell very little about people's career anchors. And the drive for money itself is not in Professor Schein's list of anchors at all; it has simply too many meanings for people.

Research Briefs

—A super-sensitive, balloon-mounted X-ray telescope launched by M.I.T. scientists in Canada successfully photographed the Crab Nebula as it was eclipsed by the earth's moon. The August 13 launch, which took advantage of a rare instance in which the moon blocked selective areas of the Nebula, was designed to map X-ray emissions from the Nebula, said Professor Walter H. G. Lewin, leader of the group from M.I.T.'s Center for Space Research.

—A 43-ton door that, when installed, will literally float on air has been delivered to M.I.T.'s Bates Linear Accelerator in Middleton, Mass. The door, which will be a radiation barrier sealing off the main truck access driveway to the accelerator, is 13 ft. high, 15 ft. wide, and three ft. thick and will rest on large flotation pads injected with compressed air. One person will be able to open and close it manually.

—Concentrations of carbon monoxide exceed federal standards on most streets in Boston and its suburbs and at most times of day, says an M.I.T. student who measured pollution levels as part of a summer project. Pedalling a bicycle equipped with a CO monitor on over 200 trips in the metropolitan area, Beth Kleiner, a junior biology major, found CO levels averaging 10 to 25 parts per million and ranging to 70 ppm. in many areas. The federal government recommends exposure to no more than an average of 9 ppm. over a 24-hour period and no more than 35 ppm. during one hour.

—Eighteen-to-20-year-old Massachusetts drivers have been involved in significantly more accidents since the state's drinking age was reduced in 1973—but the proportion of their accidents involving drinking appears to be no higher than that for older drivers. An M.I.T. research team supervised by Dr. Joseph Ferreira, Assistant Professor of Urban Studies and Operations Research, examined data from the state Registry of Motor Vehicles to reach that conclusion.

A Computer for Space

A computer-based "Institutional Space Inventory Technique System" (INSITE), originally developed by M.I.T.'s Planning Office to help maintain an inventory of the Institute's 7 million ft.^{2} of space in 120 buildings, is now finding use at five institutions which have formed a consortium to contract with M.I.T. for its use.

Rush-Presbyterian-St. Luke's Medical Center in Chicago is using INSITE for planning a substantial addition to plant, and Brown University has used the system for a parking study. Other consortium members are Syracuse University, the Harvard Medical School, and the Charles S. Draper Laboratory, Inc., which is planning a new centralized research and development laboratory in Cambridge.

Kreon L. Cyros, Associate Director of the M.I.T. Planning Office, thinks INSITE is unique: it enables users to inventory space and utilization data for many different activities and departments, based on problem-oriented commands given in simple English phrases, key words, and conventional abbreviations.

Guidebooks: Must They Be So Neutral and Bland?

If you're planning to publish a guidebook for U.S. Bicentennial travellers—hundreds of communities and civic associations will do so—here's some advice:

"Most guidebooks tend to aim at a low common denominator. . . . These bland guides fall short of their potential for sharpening public awareness and enhancing their readers' facilities for enjoyment and appreciation."

Instead, say two members of M.I.T. Department of Urban Studies and Planning, we need guidebooks that "do not hesitate to criticize or to celebrate" their subjects.

Gary Hack and Robert Hollister—both are Assistant Professors of Urban Studies—especially like *Detroit: A Young Guide to the City*, edited by Sheldon Annis. "Using it," they say in an article in *Landscape Architecture* magazine, "you feel encouraged to discriminate for yourself, to wander off, to meet people and ask questions."

Three tasks for a successful guidebook, in addition to the obvious one of helping its users find their way:

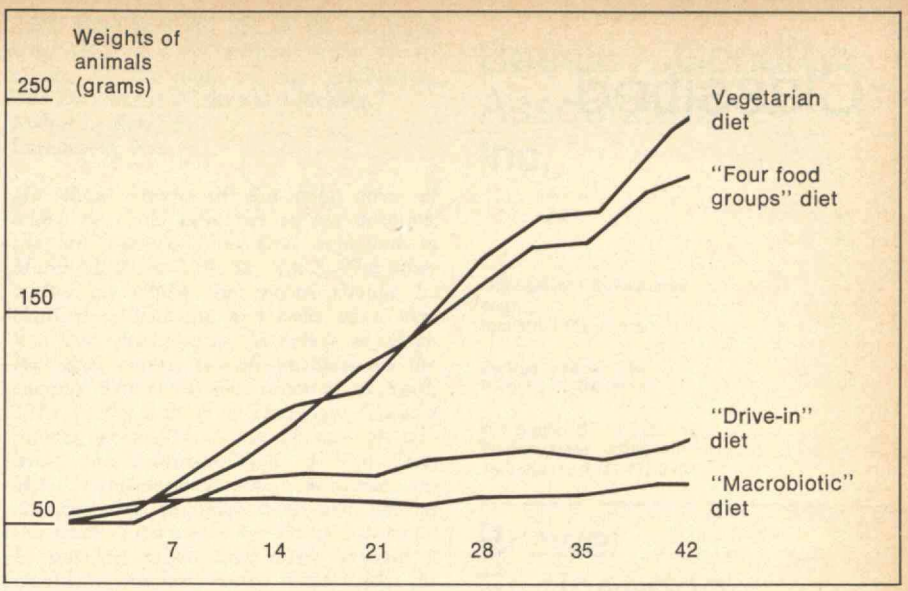
—Guidebooks can be instrumental in "stitching events and places together into some coherent theories."

—Guidebooks should be "clear and explicit about theories of urban form. . . . We acquire many of our notions about what our living environment ought to be like by seeing how others live, especially when we are away from home."

—Good guidebooks can help educate their users about ways of judging environmental and architectural quality.

"Guidebooks to be produced in the next two years of national self-congratulation and (hopefully some) introspection have an unusually strong chance to

To teach high school students the fundamentals of nutrition, two members of the M.I.T. Department of Nutrition and Food Science have devised a "minicourse" whose central feature is a typical animal experiment. Rats are fed diets typical of teen-agers' eating habits—"drive-in" hamburger meals, "macrobiotic (food fad)" meals, vegetarian meals, and "four-food-groups" family meals. The rats' performance (shown in this chart are the results of tests run at M.I.T.) intrigues the students, and they learn what today's nutrition and hygiene courses fail to communicate.



communicate the history of American urban development," write Professors Hack and Hollister, "and to shape public attitudes toward cities. . . . (Let them) encourage readers to learn about, use, and enjoy cities in new and different ways."

International Medicine for a Capital Shortage

A foreign aid program to help the U.S.?

That was a commonplace idea in the nation's early years—and even well into the 1800s, when U.S. industrial leadership was financed by money from overseas.

To James J. Needham, Chairman of the New York Stock Exchange, it's an old idea whose time has come—again. "Long years of economic complacency and, perhaps, over-indulgence," Mr. Needham said in his Buttonwood Lecture to the Sloan School of Management last fall, "may be bringing us to a point where we again require substantial infusions of foreign financial assistance to stoke our own flickering economic fires."

The problem in the U.S. is not only inflation, said Mr. Needham; it is also the prospect of a "serious capital shortage." He quoted a Stock Exchange study: $4.7 trillion will be needed in new capital in the U.S. by 1985, and only $4 trillion will be available through the U.S. economy, leaving a 13 per cent gap.

To help close it, Mr. Needham proposes changes in tax laws and a mandatory national savings plan. But those may not be enough, and so it's up to the U.S. to make American investments attractive to foreign capital.

Will the U.S. welcome foreign investment? Mr. Needham is not so sure. He wants the development of what he calls "a form of international economic populism—a stronger commitment on the part of governments and peoples to solve common problems within a framework of common benefits, . . . a broader international habit of economic thought and activity."

Learning Nutrition in a "Do-It-Yourself" Way

Concerned that Americans understand too little about nutrition and that the "four-food-groups" approach typical of elementary and high school courses is ineffective and outmoded, Shirley M. Picardi and Ernst R. Pariser of the M.I.T. Department of Nutrition and Food Sciences have devised a practical and promising alternative:

Let high school students identify diets typical of American eating habits (including especially their own), analyze their nutritional content, and test them on laboratory rats. Then, think Ms. Picardi and Mr. Pariser, the students will have a sound basis for understanding food components and the importance of balanced diets.

It's a 20-hour "minicourse," and, after some preliminary trials with high school students who visited M.I.T. laboratories on Saturdays last year, the course is now being tested in several Boston-area high schools.

Several troubles exist with conventional nutrition courses, according to Ms. Picardi and Mr. Pariser. They deal with "typical" meal components—meats, dairy products, fruits, vegetables, bread, and cereal, which are hardly relevant to today's mores—such things as vending-machine snacking, food fads, and vegetarian diets. Today's courses are inadequate to explain modern food fortification and enrichment, new synthetic foods, and new information-packed labels that are being proposed by the Food and Drug Administration. Worst of all, they are likely to be boring and "preachy."

The new course begins when students buy samples of meals to be studied—a vegetarian meal, a hamburger "drive-in" meal, a "macrobiotic" ("food fad") meal, and a typical home-style meat-potatoes-vetetable-salad meal. They feed these diets, appropriately processed, to groups of rats for three to six weeks. They keep track of the rats' appearances and weight changes while they're on the several diets, and meanwhile they carry out chemical analyses of the diets' water, carbohydrate, protein, and fat content. From the latter they calculate the caloric value of the diets.

The rats give convincing demonstrations. In the M.I.T. tests of the new course, "significant differences in weight, appearance, and behavior" were visible in three to six weeks. The "drive-in" rats showed sparseness of fur, jumpiness, and occasionally "hunched-up" postures. The "macrobiotic" rats did poorest of all, gaining least weight and showing these symptoms plus "red, splotchy, and cracked tails." Rats on the "vegetarian" and "four food groups" diets gained well.

It's true, say Ms. Picardi and Mr. Pariser, that the observed differences in the rats' growth and development cannot be related by students to particular dietary deficiencies; but the course makes the differences clear, and the students quickly discover that they are unrelated to the diets' caloric content. Ms. Picardi and Mr. Pariser are convinced that students in the new course will be motivated by their experiments to learn the nutritional details that their rats cannot tell them.

Classified

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Letters

Continued from p. 65

of economic systems or what kind of value systems they had. Certainly the pyramids of Egypt serve no "immediate practical" value, but apparently support for their construction was available. Neither was support apparently wanting for the colosseums of Roman times, nor indeed for those of our own times (e.g. the Houston Astrodome, and the one being constructed in New Orleans). Evidently, "practical" value is relative. Did Angkor Watt serve any real practical purpose?

When strictly practical things are no longer useful they are dismantled and replaced. If Astrodomes, Space Needles, Eiffel Towers, and Washington Monuments are not among our most massive structures, certainly they are among our most architecturally perfect, and it is these "useless" monuments, with their important social values (aesthetic, religious, and historical/sentimental), that survive changing concepts of economic utility. If in our times, why not so in ancient times?

Second, I submit that as a sun-dial and astronomical calendar, Stonehenge was slightly over-engineered. Even our most "primitive" contemporary cultures don't need calendars to know when planting time and harvest time are at hand. They know by the leafing of the trees and the ripeness of the grain. Events are predicted from other events; calendars are useful primarily for recording and counting.

I offer the hypothesis, then (though I am probably not the first to suggest it), that Stonehenge is (was) simply a monument, built for its own sake, an exercise in architectural magnificence, rife with astronomical symbolism (i.e. with astronomy as its central theme), but totally devoid of any occult, mystic, or programmed utility functions. The challenge then is to determine what event, person, or system of knowledge was commemorated. Consider, for example, the archeologists of future millenia contemplating the Eiffel Tower or the Mormons' monument to the sea gull.

Eugene Addor
Vicksburg, Miss.

Mr. Pfeiffer responds:
I have no argument with Mr. Addor's general point that many structures including pyramids and Eiffel Towers and Space Needles (but not including Astrodomes) have been built with little or no concern for immediate economic gain.

That was not my point, however. I was considering possible reasons for building Stonehenge and other great circles. One of those reasons, and this is the main thrust of Hawkins' book, may have been an early and surprisingly sophisticated basic interest in things astronomical, in astronomy for astronomy's sake.

But that was almost certainly not the *only* reason, and probably not the main reason. Ritual was also involved, as I indicated, and perhaps a display of personal and institutional power by new elites and new priesthoods—representing evidence for precisely those esthetic, religious, and historical values which Mr. Addor mentions.

Up a National Ladder?
Robert K. Weatherall, Director of Career Planning and Placement, has proposed to Paul E. Schindler, Jr., '74 (*see June, p. 65*) that "at M.I.T. you are interviewed by national firms, which tend to make better offers and put you on a more exciting career ladder."

The Institute is unique and all that, but it can claim no particular corner on employer demand. At Iowa State, for example, over 200 companies interviewed for B.S. graduates in mechanical engineering in each of the past several years. For the typical graduating class of 55, the choice was very good indeed. The offers are no lower and the career ladders no less exciting than those offered to M.I.T. graduates.

Since leaving the M.I.T. faculty in 1970 I have had ample opportunity to reflect on the career preparation given by the Institute. As the price differential between an undergraduate education at M.I.T. and at public institutions such as Iowa State increases, I am reluctantly concluding that the educational advantages are not worth the extra expense. I fear that this is the case even if the baccalaureate program is a prelude to graduate education.
Arthur E. Bergles, '57
Ames, Iowa

Professor Bergles, who was a member of the M.I.T. faculty from 1963 to 1970, is Chairman of the Department of Mechanical Engineering at Iowa State University. Mr. Weatherall comments:
I do believe that M.I.T. sets an ambitious student on a national career ladder, if this is what the student wants. There is all sorts of evidence for this—the number of M.I.T. alumni in key academic departments, the number of M.I.T. men at the head of major corporations, the success of our students in gaining admission to the major medical schools, and so on.

One area, however, where we have no hard evidence that an M.I.T. education makes a difference is salaries. The premium offered (above the College Placement Council average) by an industry for an M.I.T. degree has been several per cent at best. I believe that a chart showing earning curves throughout a professional's career would show M.I.T. graduates ranking above those of most engineering schools, but I have no data on this.

Off the Bullseye
A Bullseye is not a dinghy (*see October/November, p. 135*). A dinghy is in essence a rowboat with or without a sail and is quite tippy. The Bullseye, on the other hand, has 700 lbs. of lead on the bottom of its keel and is very stable. It was designed in 1914 by Nathaniel Herreshoff (M.I.T. 1870). Herreshoff, the renowned yacht designer and builder, first introduced the weighted keel that provided ballast suspended low.
George Warren Smith, '26
Pigeon Cove, Mass.

Voo Doo: Straightening the Record
Though you say ("*Institute Review,*" *March/April, p. 95*) that "*Voo Doo* died in 1959 of financial causes," I like to think—as a member of the Board of *Voo Doo*—that the work which I, as well as many other students, did on the magazine after 1959 was not without some recognition. At the time of my graduation, *Voo Doo* was still "alive and kicking."
Arthur A. Katz, '61
Larchmont, N.Y.

Mr. Katz has found the only error of which he could be aware in our account; the last issue of Voo Doo *appeared in March, 1969, as Vol. 52, No. 5. The other matter on which the record should be clarified is that the first issue of a new* Voo Doo, *promised in the article to which Mr. Katz refers, is still awaited on the campus. The status was reported in April, 1974, by the Editors of* Thursday: *"Amidst rumors, accusations, and threats of violence, the Editor-in-Chief of* Voo Doo, *M.I.T.'s still-defunct humor magazine, announced that the first issue will be out this week. Two weeks ago he said it would be out last week. Last week he said it would be out last Friday. Last Friday he said it would be out today . . ."—Ed.*

The Invasion of Acidity
The excellent survey on acid rain by Ian C. T. Nisbet (*February, pp. 8-9*) shows that most of the work has been done in western Europe, with just scattered samples in North America.

Last spring *Current Science* (a weekly science newspaper for secondary schools) operated a nationwide volunteer survey by students to ascertain, if possible, whether the New England data of Likens *et al* was matched in other states. Dr. Likens kindly helped in organizing the program and in spot-testing the procedures and equipment.

The students used a low-ion paper and a comparison color standard and reported all rains during the period from March 15 to 31, 1973. Reports were received from all states and also from schools abroad. Dr. Fredric A. Godshall of N.O.A.A. reduced the data and produced a computer-drawn map. Computer reliability tests showed that the student collected data was in sufficient quantity to be relied on to perhaps 0.5 pH.

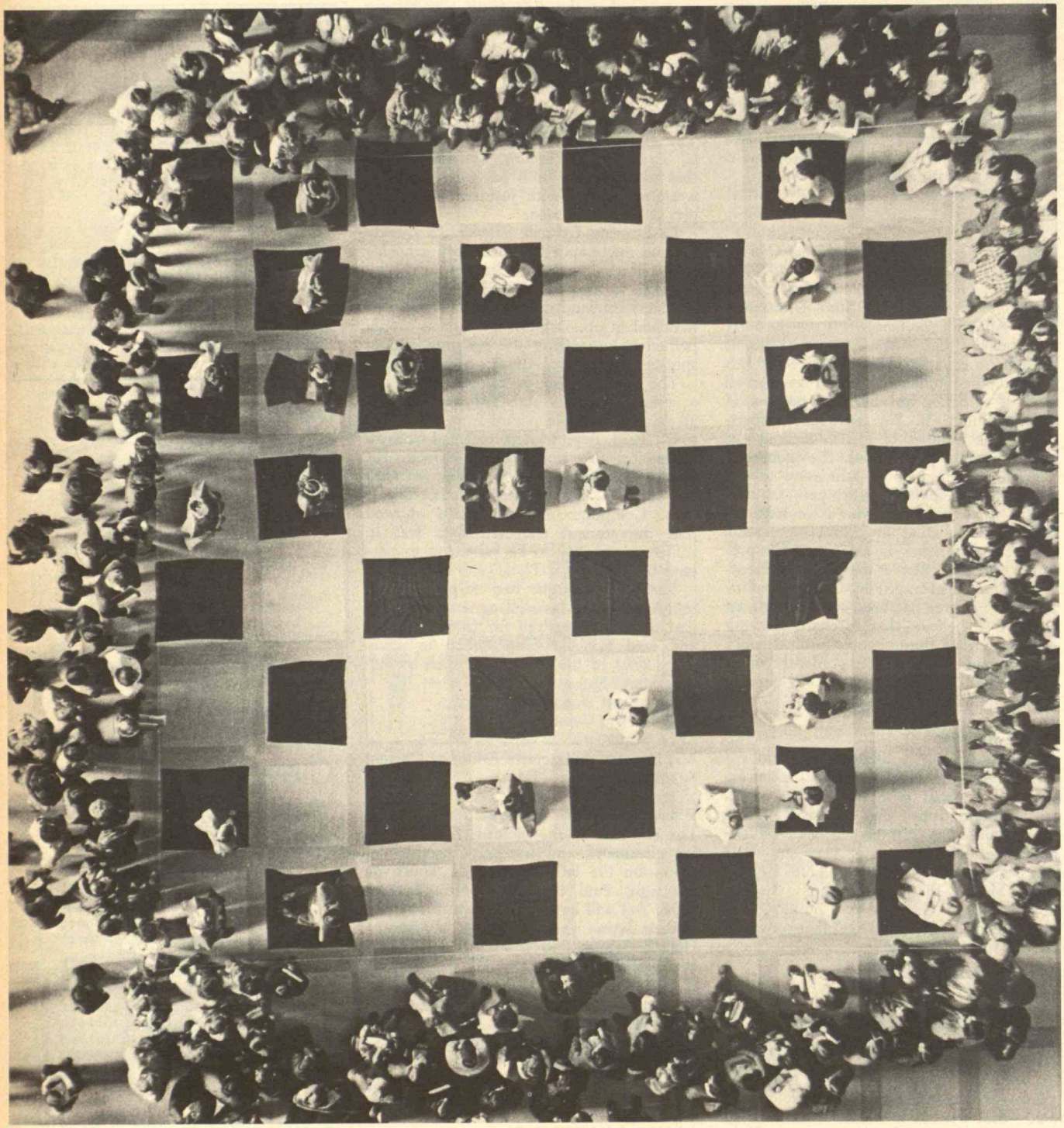
The map brought two surprises: acid rain has already invaded agricultural areas east of the Mississippi far from industry; and acid rain has also spread to many states west of the Mississippi such as Nebraska and Kansas.
Walter Scott Houston
Middletown, Conn.

Mr. Houston is Associate Editor of Current Science *magazine.—Ed.*

What's In a Name, Anyhow?
The two men in the picture (*May, p. 76*) are classmates and fraternity brothers of mine—on the left, Richard A. Thoft, on the right Paul Reppetto, both Class of 1958. You will have to ask them the names of their dates.
Hans R. Scharer, '58
Wallingford, Conn.

On the left Bill Bassichus, '59, from Cleveland, on the right Larry Roven, '60, of Stamford, Conn. Don't know the gals. I guess the year is 1957 or 1958.
C. R. Buncher
Cincinnati, Ohio

Chess fans sometimes see that ancient game as something larger than life, but they seldom have an opportunity to see it played with life-sized pieces. They had that chance at the Institute last fall, when two chess masters—Leslie H. Leow, '77, and Jerald S. Feitelson, '75, directed members of the M.I.T. Chess Club in a two-game chess duel in the lobby of Building 7. (Photo: Roger N. Goldstein, '74)



Institute Review

In This Section

The Chancellor reports to the faculty that M.I.T. will reduce its demand for unrestricted funds in operations during 1974-75. "But we need to make some profound changes in lifestyle if we are to cope with the continuing ravages of inflation," he warned **(pp. 75-76).**

Former members of the Sloan School's advanced management programs heard about the social obligations of business—and some other more immediate problems **(pp. 76-78).**

President Gerald Ford received a unique gift from outer space (by way of M.I.T.) at the White House **(p. 78).**

A new home for innovation at M.I.T. has a champion: "I was finally getting closer to home," writes Gary Eadens, '75 **(pp. 80-82).**

Also in this issue: reports on such diverse events as "An Evening with the Arts" **(pp. 82-83),** a Sea Grant Lecture **(pp. 83-84),** a roller skating exhibition in Building 7 **(p. 84),** the Head-of-the-Charles Regatta **(pp. 84-85),** the Ugliest-Man-on-Campus **(p. 86),** a bicycle based survey of highway pollutants **(p. 89).**

A Budget More Nearly in Balance in 1974-75, But a Continuing $2 Million Problem

In somewhat the same vein as a rash of recently popular jokes, Chancellor Paul E. Gray, '54, brought to the faculty during the fall both good and bad news about M.I.T.'s current and future financial prospects.

The good news was that the difference between operating expenses and normal operating revenues will be somewhat less this year (1974-75) than last year (1973-74), thereby reducing slightly the demand for unrestricted funds required in operations.

Where $8.6 million in unrestricted funds was needed last year *(see December, pp. 105-106),* Dr. Gray said, current projections are that this need will be down to $6.6 million in the current year.

The bad news was that the normal annual flow of unrestricted revenues is insufficient to meet the present needs for these funds in balancing the operating budget. Consequently, it was necessary last year, and will be necessary again this year, to call on reserve funds of the Institute to offset the differences between operating expenses and current operating income, including unrestricted income.

Costs Growing, Income Steady

The cost of running M.I.T. last year came to a total of $223.8 million, and this year's costs will be slightly higher, Chancellor Gray said.

Unlike some colleges and universities, M.I.T. has not yet had to invade endowments or sell off investments to balance the budget. Nor is that prospect imminent.

"But we need to make some profound changes in lifestyle if we are to cope with the continuing ravages of inflation," Chancellor Gray said. "We must continue to look to everyone at the Institute to do what he or she can to save money, to economize, and to reduce expenses wherever possible.

"We expect to achieve a balance between operating expenses and normal annual operating revenues, including budgetable unrestricted revenues, for the fiscal year 1976-77. Until then, we will probably have to continue the use of reserves accumulated in earlier years to balance the operating budget."

This year's $6.6 million total demand for unrestricted funds in operations, Chancellor Gray said, will be met, in part, with use of facilities allowances ($1.2 million), patent revenues ($0.9 million), and anticipated current unrestricted gifts ($1.3 million), leaving approximately $3.2 million to be drawn from unrestricted funds accumulated in prior years or from reserves.

To Conquer a Chronic Imbalance

"Our most serious problem for the long run is not, however, the differences between expenses and current revenues that existed last year and that will exist this year," Chancellor Gray said. "Our most serious problem results from the fact that expenses grow faster then revenues, and the reasons for this imbalance in growth rates appear both chronic and deeply rooted.

"At the present time, the imbalance in growth rates amounts to $1.5 to $2.5 million per year. That is, if the operating budget were balanced this year, and if no changes in programs were made, the budget would be out of balance by $1.5 to $2.5 million next year, by $3 to $5 million the following year, and so on.

"The amount of money involved in this year-to-year imbalance in the operating gap is equivalent to the expenses of one medium-sized academic department, or to the tuition revenues generated by 600 students, or to the additional revenues that would be generated by an 18 per cent per year rate of growth in the tuition fee, or to an increase in the principal of the Institute's endowment of about $30 million per year, each year.

"None of these equivalencies suggests a possible or tolerable solution in and of itself," Dr. Gray said. "But they do give people a feeling for the dimensions of the annual budget problem. Our ultimate solutions will, of course, be multiple in nature. Clearly, we must seek understanding, assistance, and initiative on the part of everyone concerned if the continuing strength of the Institute is to be preserved."□

Reducing the Budget: A Self-Study in the School of Engineering

Concerned by the implications of M.I.T.'s need to trim up to $2.5 million from its budgets for 1975-76 and to make what Chancellor Paul E. Gray, '54, calls "profound changes in lifestyle," members of the faculty and staff of the School of Engineering have mounted a major internal review of teaching, research, and administrative operations.

Nineteen task forces have been assigned to as many areas of the School's operations; their reports are due by the end of January, and a final report of the $50,000 self-study project is expected by March 1, according to Alfred A. H. Keil, Dean of the School.

Last fall, soon after Dr. Gray reported to the faculty on the Institute's financial prospects, Dean Keil and James D. Bruce, Sc.D.'64, Associate Dean, wrote to Dr. Gray of their concern that "year-by-year cuts will not work."

"We could go on, year after year, cutting $2 million out of our budgets," Dean Bruce told Michael D. McNamee, '76, of *The Tech*, "but eventually there would be nothing left to cut. Each year we would come closer and closer to zero."

The only alternative was the major effort now under way. "Our purpose is to assume that anything can be changed, and then to look at the implications of changing it," Dean Bruce said. "The School feels it has to look out for itself, and we want to review as much of this ourselves as we can."

Faculty are taking a major role in the study, Dean Bruce said, because "the faculty are the ones who must respond if any efforts to cut the budget are going to succeed." Indeed, 20 to 25 per cent of the entire School of Engineering faculty are members of the various task forces, which deal with three broad areas.

Two groups are studying changes in the engineering profession which may affect the School's programs—the future demand for engineers and the types of engineers and of training that will be needed.

Nine task forces are studying organizational improvements—"how we do business," Dean Bruce explained. They will look into such matters as overlapping and parallel courses, cooperative ventures with other schools, space utilization, financial management, administrative costs, and personnel policy—including tenure.

A third series of task forces is at work on programs for which income might exceed outgo—cooperative study with industry, research, continuing education and special seminars, increased enrollment, and other income-generating activities. An important issue in this area, according to Dean Bruce, is "the way our services are priced."

The Sloan Fellows Return: Private Corporate Survival Depends on Corporate Citizenship

Should private institutions be put on the endangered species list? They should indeed, thinks Howard W. Johnson, Chairman of the M.I.T. Corporation, for government—even with the best of intentions—is gradually encroaching on private initiative.

A surprising general consensus, but by no means a unanimous one, from the 1974 Convocation of Sloan Fellows at M.I.T. this October.

At the very least, it was agreed, private industries must make their presence felt as "corporate citizens of the community," as Gerhard D. Bleiken, '58, Chairman of the Board of the John Hancock Insurance Co., put it. Herman R. Staudt, S.M.'68, Undersecretary of the Army, predicted that if senior industrialists "continue to put public good after private need" on their lists of priorities, the extinction of private enterprise is inevitable.

How does industry respond to its role as a corporate citizen? A panacea to conservative industrialists—look for profitable opportunities in problems. An example offered by Oliver C. Boileau, Jr., '64, President of the Boeing Aerospace Co., was the conversion of Boeing's moon buggy to people mover, a profitable response to demand for low-energy transportation.

Let the company consider its employees' total life situations—that totality has a direct relationship to job satisfaction and performance, suggested Undersecretary Staudt. For example, he said, "Soldiers are human," affected by their leaders, their surroundings, their homes and their peers.

In the same spirit, Mr. Bleiken described the Hancock company's efforts to improve the workers' environment in the city in which they live—developing plans for employees' reduced mass transit rates and working in Boston high schools two months before school busing began in an effort to help ease a critical situation.

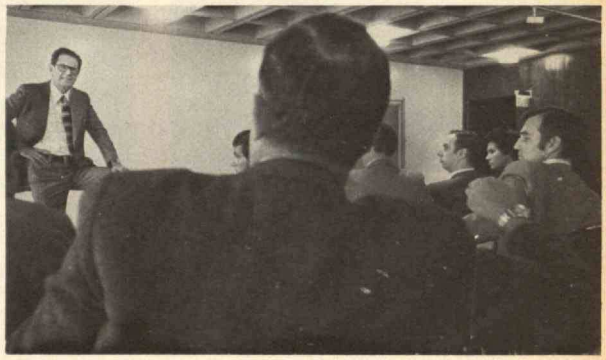
A tight economy is no excuse; programs such as these are in no sense marginal. "You cut out a program and save $10,000 and lose a city in the process," said Mr. Bleiken. "We live here. We aren't about to pack up and move; we've got to stay involved." Echoing his sentiments, Donald E. Procknow, S.M.'63, President of the Western Electric Co., said that "what people want is what we're going to be doing if we want to stay in business."

Nothing simple about such efforts—private institutions, including business, are ill-equipped to deal with social changes and problems. "Corporate culture gets in the way when industry tries to solve societal problems," said Edward B. Roberts, '57, Sarnoff Professor in the Sloan School. A new culture is needed, he said, with organizational structures flexible enough to allow for such changes—a culture which allows social as well as economic and competitive advantages to weigh in planning and decision-making.

The concept of "corporate citizen" becomes more complex when applied to multinational corporations. Such companies have multinational citizenship, said Wylie S. Robson, S.M.'56, Executive Vice President of Eastman Kodak Co. Though they are "poor agents for social change," they still have responsibilities to local workers' education, health, and financial security. And they have a special opportunity and responsibility as channels for technology transfer.

New technology generates new taxes, but multinational companies cannot assume that their responsibilities are fulfilled through taxes to the host nation. Let them realize that the importance of technology transfer "does not decline over time. Technology does not stand still for transfer," said Mr. Robson. □

Though M.I.T. was never exactly like this, there were lots of familiar faces at the Soan School's management convocation last fall. Among the latter (clockwise around the four pictures top left): William F. Pounds, Dean of the School; Wylie S. Robson, S.M.'56, of Eastman Kodak Co.; Edward B. Roberts, '57, Sarnoff Professor; and Howard W. Johnson, Chairman of the Corporation. (Photos: Bradford Herzog)



Plenty of Problems—But Price Is Not One of Them

Even if today's belt-tightening economy won't discourage company efforts to be "good corporate citizens of the community" *(see above)*, the uncertain state of present and future business hung like a storm cloud over the reunion of Sloan Fellows and Senior Executives at M.I.T. last fall.

"It's a very different world," said Arnold E. Amstutz, '58, Senior Lecturer in the Sloan School—a time of unique problems and unique opportunities. His seminar, with the ambitious title of "Short-Term Strategic Planning in a Crisis-Oriented Environment," was a sell-out, given twice to standing-room-only audiences.

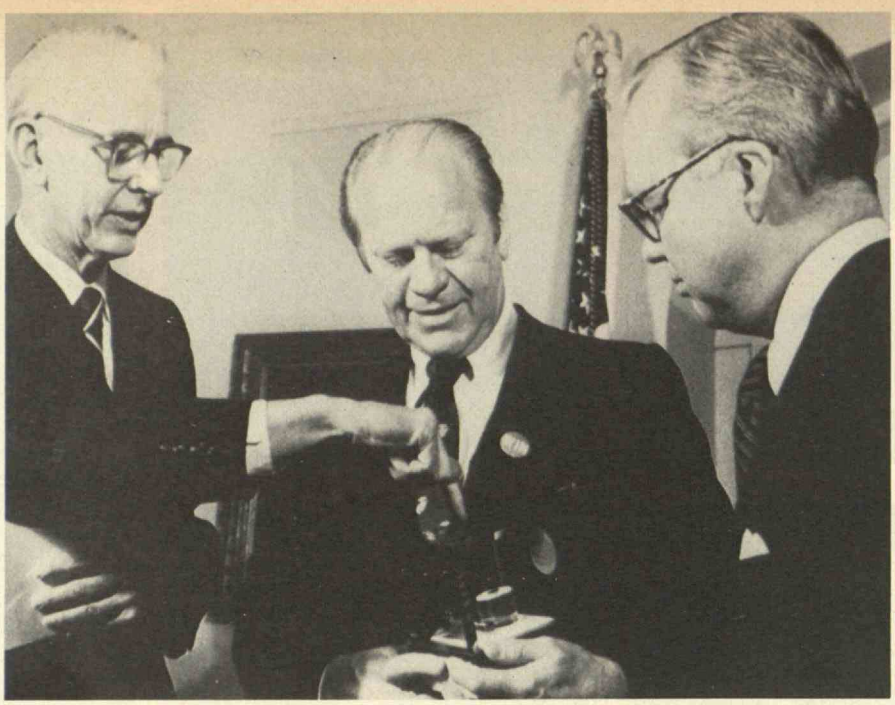
Opportunities? "The crisis lets you get back to real management . . . do things that couldn't be done under any other conditions," he said. That includes reduced inventories (make the customers wait, and save the cost of storage), reduced selling costs, simplified advertising, pruning the market (eliminating marginal lines and marginal customers), lots of effort on seeking new profit opportunities, joining with competitors to attack prices and increase efficiency.

"What was unthinkable is now doable," said Dr. Amstutz. "All of a sudden we can take dramatic action with impunity." Earlier this fall an executive told him, "I'm being applauded today for actions I'd have been called on the carpet for a year ago."

But such an environment also brings problems. Top-level management is spending lots of time on short-term contingencies, and "the planning cycle has been reduced dramatically." In that situation, management needs more information faster—expanded reports from salespeople, computer-based short-term planning models, faster data input and data processing. And all of it must be "bottom-line oriented."

Dr. Amstutz finds it all very exciting—a fast-paced, exacting environment for corporate information specialists. And doubly exciting, he said, because "all this is going on at the highest levels of management. . . . A very different world," he said.

One new problem that nobody thought would be a problem: "We all know what to do with a product that doesn't sell," said Dr. Amstutz. "But what to do with a product that 'takes off' under today's conditions?" Hard to find cash, hard to find resources, and hard to find manpower to capitalize on that opportunity. Only one thing is easy: "Price is no problem; we can move it up and down."□



After he had given a crystal segment grown in space aboard Skylab III to President Gerald Ford (center), Howard W. Johnson, Chairman of the M.I.T. Corporation, was asked if the Russians had tried a similar crystal-growing experiment in space. Mr. Johnson didn't know, but "if they haven't, they're missing a bet," he said. President Ford said he will keep the section of indium-antimonide crystal in his White House Oval Office as a constant reminder of "the broadening horizon available to us through our national investment in science and technology." James C. Fletcher (left), Administrator of the National Aeronautics and Space Administration, said that the more uniform and perfect crystals grown in the absence of gravity "could lead to another significant step in electronic circuit miniaturization." (Photo: United Press International Newspictures)

For President Ford from Chairman Johnson: A Crystal More Perfect than Grown on Earth

November 4 was M.I.T. day at the White House. Howard W. Johnson, Chairman of the Corporation, was an official visitor, and he brought with him—as a gift to President Gerald R. Ford—a segment of a crystal grown in space aboard Skylab III, the result of an M.I.T. experiment with potentially far-reaching consequences.

The President told Mr. Johnson that the segment—the product of an experiment developed by Professors Harry C. Gatos and August F. Witt and their associates in the Center for Materials Science and Engineering—served as a reminder that "most of us become so involved in trying to find solutions to the serious problems that we face today that we sometimes lose sight of the developments that hold promise for a better tomorrow."

The crystal experiment, carried out aboard the Skylab III Space Station one year ago (*see "Superior Crystals Grown in Space," June, pp. 48-50*), demonstrated that it is possible to grow crystals in space, in the absence of gravity, that are more uniform and perfect than the earth-grown variety.

Scientists believe this experiment could eventually lead to significantly improved technology for electronic equipment from television sets to computers.

"But beyond its scientific value and potential applications for this new knowledge," President Ford said, "this successful demonstration serves as a useful reminder of the contributions that science and technology make toward improving and enriching our daily lives."

Mr. Johnson, at a press conference following the presentation, characterized the Skylab experiment "as an example—one of the few—in which one sees immediate return." Many space experiments are much longer-range in terms of applicability, he said, but crystals of the kind grown on Skylab III could be immediately useful.

In the future, he speculated, it might be possible to grow crystals in unmanned space vehicles.□

Publishing Costs Up, Book Market Down—Trouble at the Press

Fifteen years ago Datus C. Smith, Jr., then Director of the Princeton University Press, reported for the members of a study committee appointed by President Julius A. Stratton, '23, that the Institute "would be incomplete, and in our view would be neglectful of its duty as one of the leading intellectual institutions of the world, if it failed to make adequate provision for scholarly publishing as an integral and indispensable part of its responsibility."

Still true today, says Constantine B. Simonides, Vice President of the Institute—despite general market and management problems which have resulted in substantial losses by the M.I.T. Press in 1972, 1973, and 1974.

The M.I.T. Press is regarded as "one of the top publishers in architecture and planning and in linguistics," says Hartley Rogers, Associate Provost of the Institute who is Chairman of the Press' Editorial Board. "And we intend to stay at the top in these areas," he insists, "while pressing hard to achieve greater distinction in the physical and biological sciences and in engineering."

Mr. Simonides, who has stepped in to manage M.I.T. Press operations until a new Director can be found (Howard W. Webber, Director since 1970, resigned in mid-summer), agrees; he stresses the importance of maintaining "the intellectual quality of the Press and its independence of judgement as a publishing entity."

No easy task, he admits, since the Press is confronted by general market problems—rapidly escalating costs and reduced library acquisitions—and a set of difficulties all its own relating to printing, pricing, and credit policy. To relieve what he describes as a "critical" situation, Mr. Simonides is overseeing the write-down of overvalued inventories and detailed reviews of marketing, editorial, and fulfillment policies and methods. "Tight budget controls" have been adopted, and there has been "a rather considerable reduction of staff"—from 67 in 1973-74 to 48 today.□

The Activity/Fraternity that Tackles Anything

What fraternity has an office instead of a house, helps rather than "rushes" freshmen during Residence/Orientaton Week, and offers the volunteer services of its members to any organization that needs their help?

Every member of the Alpha Chi Chapter of Alpha Phi Omega—from the newest pledges to the alumni—pitches in to help the Boy and Girl Scouts, hospitals, institutions, and other organizations that need their services. Tasks can be anything from clearing land to painting interiors—just as long as the beneficiaries are not on a long-range basis or for private parties. (Photos: A.P.O. Historians)

The answer: Alpha Chi Chapter of Alpha Phi Omega, a service fraternity which has 50 M.I.T. undergraduates as members—30 "actives" or formal members and 20 "pledges"; 35 per cent of the "actives" are women, members of the "auxiliary."

Alpha Phi Omega, the national service fraternity whose Cambridge chapter was established at M.I.T. in 1936, aids those—hospitals, Girl Scouts, institutions, among others—who have work to be done. These jobs, ranging anywhere from building a watchtower at a Boy Scout Camp in New Hampshire to collecting books for the Norfolk Prison library, have also included the production of a handicapped students' map of the campus as well as two guides to architectural barriers in Boston and Cambridge.

To the M.I.T. community, A.P.O. offers services such as a used-book exchange twice a year, daily posting of the *New York Times* in Building 7, distribution of Student Directories, and refreshment booths at Institute-wide events. However, as Seymour Danberg, '77, an A.P.O. member, told *Tech Talk*, "We cannot accommodate private parties who want their houses painted or roofs shingled. Nor can we commit ourselves to a long-range ongoing project such as tutoring individual students. Our success comes from the fact that we work together and we work hard—that's our only stipulation."

And working hard is what they'll be doing for the next few months as a result of an article by Mary Sarah King of The *Boston Globe* in which their help was "advertised." Shortly after the paper hit the newsstands, calls began to flood the office in the Student Center; within two weeks, nearly 20 invitations had come in by both mail and telephone.

One of 570 chapters, this non-profit organization is probably best known around M.I.T. for sponsoring the "Ugliest Man On Campus (U.M.O.C.) Contest" to raise funds for C.A.R.E. A penny is donated as a vote for the ugliest candidate and whoever has the most pennies at the end of the contest wins. All proceeds go to C.A.R.E., and this year the votes amounted to $2,205—a lot of money to be handled in pennies, nickels, and dimes.

An Incubator for Inventions; Or How to Be an Entrepreneur While Still an M.I.T. Student

How many ideas are born at M.I.T. every day? And what happens to them all?

No one knows. But the Institute's Innovation Center represents an attempt to provide an incubator for a handful of them. The concept is simple. If you've invented something, bring it to the Innovation Center. There you'll find a sympathetic ear and lots of advice aimed at getting technological ideas off the drawing board and into the market place.

Some ideas are already well on the way, the fruits of the Innovation Center's first year of activities. An electric guitar which allows the player to control the fuzz and volume of each string was the brainchild of Jacob Moskowitz, M.A.'72, while he was a graduate student at M.I.T. Other students from last year's classes are working in an invention development laboratory on such proposals as an electronic game package adaptable to any television set, a low-energy pulse-width amplifier, and a new method for cleaning cargo and ballast holds of oil tankers. A heating, ventilating, and air conditioning controller developed by Philip Doucet, '74, and John Reese, '74, will be installed for testing this year in a Boston-area commercial building.

These—and some other ideas which are in lesser states of development—were the subject of an exhibition of Center activities planned to stimulate student interest this fall. And there was more here than met the casual visitor's eye. The real point of the open house lay in the unique Innovations Center program that allows students to work with faculty and outsiders in evaluating and marketing inventions.

Seminar courses and laboratories have as their purpose "to prepare students to be good inventors, and to teach them how to bring their inventions to production and marketing," Professor Y. T. Lee, Sc.D.'39, who is Director of the Innovation Center, told Mitchell Trachtenberg, '78, of *The Tech*. Enrollment figures suggest growing success: 40 students were enrolled last year, the first year of this program co-sponsored by the School of Engineering and the Sloan School of Management; and an additional 100 are participating this year

The purpose of the Center, as explained in the information brochure, is "to introduce a new educational dimension at M.I.T. for the training of innovators and entrepreneurs." There are formal classes, but many students prefer the experience they can gain through the Center's product development laboratory, whose goal is to help them "to develop new products and license them to industry or new business ventures for mass production."

Adding a new twist this year, the Center is testing an outside invention program in which student teams survey the Innovation Center's interest and competence to develop inventions submitted from outside the Institute community. This plan is still in the neophyte phase, and the Co-op can accept only a limited number of inventions or ideas for new products and processes, but any outstanding proposal will be given every consideration. (Further information on this aspect can be obtained from the M.I.T. Innovation Center, Room 33-111, M.I.T., Cambridge, Mass., 02139.)

There are many stages in the creation and birth of a new invention: research, development, testing, commercializing. The Innovation Center deals with all of them, all the time emphasizing the educational viewpoint by involving students. Indeed, that may be the greatest invention of all—kindling new knowledge along with new concepts.—*C.S.* □

A heating, ventilating, and air conditioning controller such as this one with one of its developers, Philip Doucet, '74, is scheduled to be installed for testing in a Boston-area commercial building.

The Making of an Innovator: "Getting Closer to Home"

Gary Eadens, '75

Gary Eadens, '75, and Professor Y. T. Li's tiltmeter—used to measure microscopically-small angles of off-vertical tilt.

Technology Review *asked Gary Eadens, '75, of Scott City, Kansas, to write about his experiences at the Innovation Center. Besides majoring in aeronautics and astronautics, Gary won a varsity letter in Lightweight Crew during his sophomore year, and has rowed in both varsity boats since then. After graduation, he hopes to obtain practical experience working for a large outside company and then initiate his own firm—dealing with high technology—within five years.*

I came to M.I.T. in 1971 with one goal in mind: I wanted to be an inventor. I wasn't sure how I could learn more about this occupation, but I was confident some course or combination of courses would prove sufficient. A year and a half later and still without a major, I wasn't any closer to my original goal; frankly, I was almost ready to give up and look elsewhere for an education.

But leaving M.I.T. is not easily done, and I decided to first speak with Professor Robert L. Halfman, '44, Assistant Dean for Students. After listening to my troubles, he called on his endless store of knowledge about M.I.T. people and projects to come up with a name—Dr. Yao T. Li, Sc.D.'39. Dr. Li, Professor of Aeronautics and Astronautics, had come from mainland China to M.I.T. in 1937, and after completing his education and further work in China, joined the faculty in 1947. Since then, he has founded two successful companies and poured forth a veritable flood of innovations. When I expressed my intention to become an inventor, or an innovator as he called it, Dr. Li invited me to join his seminar on the innovative process. There he could speak more extensively on the technical background and experience needed to become a successful innovator.

The first semester in the Innovation Seminar was a combination of fiery promise for the future counteracted by the disorganization of the present. Dr. Li was still in the process of convincing the National Science Foundation (N.S.F.) to provide funds for an organization he was forming—the Innovation Center. In addition to his trips to see N.S.F. people in Washington, D.C., there was also teaching, managing his own private firm, and planning out administrative details for the Center to keep him busy.

Yet after the first few classes I was glad that I had accepted his offer; I was finally getting closer to home. Professor Li had an enthusiasm that inspired those around him, and when he spoke, not only on the innovative process, but also about future plans for the seminar and the Innovation Center, I knew this program would ideally suit my needs.

As for the course itself, there was a two-hour lecture every week accompanied by occasional assignments. Perhaps the most interesting of these assignments was presented by one of the top design engineers at Pratt-Whitney Aircraft (Hartford, Conn.). Their problem dealt with the seals used around the joints of their largest aircraft engine's outer casings. Our assignment, to design a better seal for a Boeing 747 engine. The engineer explained the environment for these seals' functioning in detail, and after we presented our schemes, he analyzed our individual proposals. His compliments and criticisms provided an education now more commonly found at M.I.T.—the education of experience.

By the 1973-74 Fall Term, the Innovation Center was a going concern with complete approval from M.I.T.—over 1.125 million dollars of funding from the N.S.F., and a variety of courses. One course—"Entrepreneurship"—was probably the largest concentration of information on product development and company initiation ever assembled at M.I.T. I immediately enrolled.

In the course, successful entrepreneurs lectured on their various experiences in the business world. To furnish a well-rounded picture of the problems they faced, Dr. Li brought in professionals involved in initiating businesses: a marketing expert, a bank official, a venture capitalist, and an aircraft corporation administrator. Especially enjoyable was the chance to exchange ideas with the speakers, most of whom were men who had attained their goals in life and were readily willing to discuss their pasts.

If any of our inventions become commercially successful, a percentage of net sales of royalties will be returned to the Innovation Center to continue the development of new projects and new innovators like myself.□

The McDermott Award for Art as Fulfillment

". . . the arts and sciences are but two means to a common end: the enhancement of the human spirit and the betterment of the world."

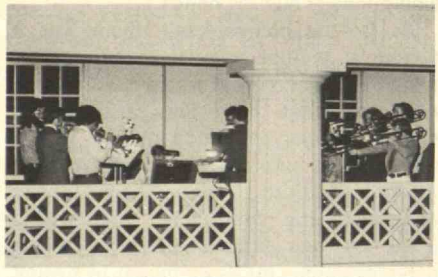
. . . a key phrase in the citation for the first Eugene McDermott Award of the Council for the Arts at M.I.T., given this fall to Gyorgy Kepes, Institute Professor and Professor of Visual Design, Emeritus.

The Award will be made annually, presented "for major contributions to the arts as a means of human fulfillment," and Professor Kepes is "the very model of the guide we seek" in presenting it, said Paul Tishman, '24, Chairman of the Council. And he quoted Professor Kepes: "Our age falls short in the harmonizing of our outer and our inner wealth. We lack the depth of feeling and the range of sensibility needed to retain the riches that science and technology have brought within our grasp. Consequently we lack a model that could guide us to re-form our formless world."

Professor Kepes, who is spending the year at the American Academy in Rome, could not return to M.I.T. for the ceremony; he was, he said, already committed to a conference on science and art in Europe. But he wrote in a cablegram, he was "pleased and moved" by the Council's action, which he takes both as "a personal honor and an act of trust in the cause of the convergence of art and science."

A native of Hungary, Professor Kepes studied at the Bauhaus before coming to the U.S.; he joined the M.I.T. Department of Architecture in 1945, and since then, said Mr. Tishman, he has "been responsible more than any other individual for the flowering of the arts at M.I.T." His greatest contribution, thinks Mr. Tishman, came in 1967 through the founding of the Center for Advanced Visual Studies, for it made possible "the fruitful collaboration of artists and other members of the Institute community."

The late Eugene McDermott, for whom the award is named, was a pioneer advocate and member of the Council for the Arts at M.I.T. His generosity made possible the Institute's acquisition of the Alexander Calder sculpture which graces the court of Mr. McDermott's name.□



Many distinguished names appear in the guest book for "An Evening with the Arts"; two of them are those of Luis A. Ferre, '23 (left, above) and Mrs. Harris Fahnestock. While they signed amidst festivities and conversation on the floor of Walker Memorial, a brass choir played on the balcony.

The Arts: Commitment to Aesthetics and Fun

Though the columns of Walker Memorial withstood the assault of Herb Pomeroy and the M.I.T. Concert Jazz Band, some members of the Council for the Arts at M.I.T.—and of the faculty who were their guests—found the decibels almost too much. The occasion was "An Evening with the Arts," an informal exposition of the arts at M.I.T. preceding the annual meeting of the Council in November, and Professor Roy Lamson, Special Assistant to the President for the Arts, had warned that the band would "take the pillars down."

The point, said Professor Lamson, was to show that doing and experiencing art at M.I.T. can be fun; there were also numbers by a woodwind quintet and exhibits of work from the Visible Language Laboratory, the Center for Advanced Visual Studies, the Creative Photography Laboratory, M.I.T. Design Services, and Professor Richard Leacock's motion picture studios—a kind of art-oriented "night club" enlivened by champagne and punch.

The Council's serious business came the next day, when Luis A. Ferre, '24, President of the Alumni Association, cited his personal experiences in urging the importance of the arts as central parts of life essential to human happiness. The pragmatic concerns of science and technology have been blamed for the isolation of the arts in modern society, he said—hence the significance of M.I.T.'s new emphasis on art experience and education.

Another reason, said President Jerome B. Wiesner: Humanists and artists need the discipline and techniques of science and engineering, and students of technology need the freedom of a liberal education to understand the world in which they will work; as well as to share in the pleasures it offers. We need to "lead the way toward that new industrial society which recognizes aesthetic excellence as well as efficiency," Dr. Wiesner said.

To that assignment M.I.T. brings spe-

cial qualifications, thinks Dr. Wiesner—a student body composed of young people "anxious to engage the world," having a tradition of experiment, and a concern for the contemporary. As a result, the arts are growing rapidly here—more enrollment in music this year than even before, increasing recognition for the Center for Advanced Visual Studies, and equal status for music and the visual arts with other humanities disciplines in the undergraduate curriculum.

On a more pragmatic level, Dr. Wiesner credits M.I.T. emphasis on the arts as "an important element" in the Institute's 20 per cent increase (over 1973) in applications for entrance in September, 1974.

But success breeds problems: "Present facilities are clearly inadequate for present programs," said President Wiesner, and he admitted that it is "a gloomy moment to be talking about the need for large sums of money."

Other unresolved issues demand some basic decisions for the long term. What direction should M.I.T. take? Continue the present "accidental diffusion" of the arts throughout the M.I.T. campus, which assures that they will be "thoroughly imbedded" in educational activities? Or centralize the new facilities that are needed?

Whatever the decision, said President Wiesner, "we intend to foster the continuing role of M.I.T. in the arts," and that will include commitments, traditional at M.I.T., to both teaching and research.□

Art in the "Mainstream of Practical Life"

The following is an excerpt of remarks by Vernon R. Alden, Chairman of the Massachusetts Council on the Arts and Humanities, at the annual meeting of the Council for the Arts at M.I.T. in November:

The explosion of knowledge and the consequences of that knowledge have brought us both major advances and severe problems. The "disassociation of sensibility" lamented by T. S. Eliot has struck the modern world with a vengeance and threatens to make us a nation of technocrats without a guiding vision. The division of labor has cut us off from our roots. The headlong growth of industry and government has tended to discredit the very science and technology on which we have become dependent. We have compartmentalized ourselves in every aspect of our lives, and within the university a growing institutional structure tends to reinforce the divisions that thwart creative solutions. From my own experience in the university world, new perceptions are not infrequently dealt with by lengthening the roster of disciplines rather than by allowing these new techniques and understanding to infect the whole.

Our reluctance to reassess our basic structural models has created obvious problems. These problems have already effected a change in public awareness, and that change in attitude has begun to crystallize into the specific political issue that we have come to call "the quality of life." This issue seeks to bring together the physics of our experience with the aesthetics of our experience. This is not simply a matter of reordering our priorities; it calls for the rediscovery of the colleagueship of separate talents which has persisted through most of human history but has been mislaid in the recent rush to the specialization of human effort. The 19th century put the artist in the garret, and only recently has he begun to reassert his central role as an *integrator* of our experience.

Our institutions now support workshops and symposia about the arts and technology, the arts and society, the arts and urban planning, the arts and environment, the arts and industry. But artists themselves are rarely provided with adequate resources to make significant contributions to problem-solving in these areas. We support individual artists and create separate centers for the visual arts. But we often fail to provide the tools commensurate with that mandate and the central role in decision-making which would give that mandate meaning.

We must reintegrate the arts into our common experience. But to do this takes commitment, and it takes money. We expect to pay large bills for scientific research, with the understanding that that research is fraught with uncertainties and that money merely buys time, the application of excellent minds, and the tools and resources necessary for experimentation. The same investment, the same confidence, the same patience must be given to the arts. When it is not, we diminish not only the arts but ourselves as well.□

Newspaper Technology, Minority Education

Two grants announced this fall will support new teaching programs and student groups at M.I.T.:

—The Frank E. Gannett Newspaper Foundation, Inc., has provided a $125,500 three-year grant for graduate students interested in modern technologies affecting the editing and production of newspapers—digital communications, scanners, phototypesetters, systems analysis, etc. There will be several fellowships, a seminar series, and a major conference on newspaper technology.

—The Sloan School of Management will share, with nine other business schools, a $600,000 Alfred P. Sloan Foundation grant to the Council for Opportunity in Graduate Management Education. The funds will support graduate management education for members of minority groups at the ten leading business schools.□

Think Positively and Emerge from the Dark

In understanding his impact on the world environment, mankind has reached the stage of the child who is afraid of the dark but is not sure yet if his fears are justified and so is just a bit scared to admit them.

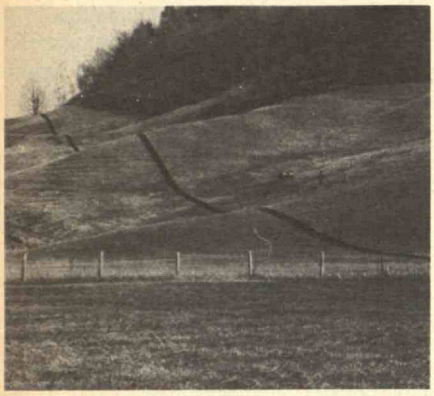
We're still in that stage, thinks Robert A. Frosch, Assistant Executive Director of the United Nations Environment Program, with a long list of environmental bogeymen: depletion of energy and materials sources, poor forest and land management, and the impact of man-made pollutants. The most dangerous issue is our ignorance, said Dr. Frosch in the annual Sea Grant Lecture at M.I.T. this fall, and our history of mismanaging land-based resources does not bode well for man's projected future on and under the oceans.

Speculating on future opportunities for ocean management, Dr. Frosch reviewed proposals for stimulating upwelling of cold sea-bottom water to spin turbines and generate electricity. This upwelling would also bring nutrient-rich bottom water to the surface, a side-effect that would cause a "bloom" of living creatures, which might be either damaging or purposefully useful. Perhaps the "bloom" of such an upwelling could be used as food or even to alter weather patterns. His point was that "There is nothing necessarily wrong with the construction of artificial ecosystems." Indeed, man-made ecologies created through engineering may provide precisely the kind of en-

vironment man wants to live in; marine animal husbandry and mariculture are examples. But we still can't be sure.

Logical management policies will not emerge from the adversary process of the law. What's needed is the problem-solving mode of the engineer and scientist. For example, thinks Dr. Frosch, the nation would benefit more from studies of ways to use pollutants for economic benefit than from continued threats of punishment and other economic disincentives to pollution.□

An Intervention in the Vermont Environment



Planning an "intervention" on a hillside behind Talbot House in Woodstock, Vt., M.I.T. students in Professor Wayne V. Andersen's seminar in environmental symbolism used black roofing paper to define a line across a pasture, then replaced it with high-nitrogen fertilizer; a green line shortly appeared in the grass and remained visible throughout the summer—an ideal intervention because it will gradually disappear.

Environmental symbolism? Interventions in landscape?

The first is the title of a seminar given by Professor Wayne V. Andersen, Chairman of the Committee on the Visual Arts. The second, the title of a Hayden Gallery exhibition in the spring of 1974.

The two came together when Professor Andersen's students decided to try an "intervention" of their own, and for the purpose they spent a week at Talbot House, M.I.T.'s "retreat" near Woodstock, Vt.

The landscape intervened upon was a hill behind Talbot House that Professor Andersen had "borrowed" from Laurance Rockefeller, its owner, with the assurance that the project would not alter the landscape significantly. The problem posed to the students: How to define effectively the spatial quality of the hill by the most economical means without disturbing its ecology.

The solution decided on was to make a straight line three feet wide from the back yard of Talbot House across rolling pasture 1,680 feet to a lone tree at the base of the hill. When seen from different points, the line would break into visual segments describing the shape and spatial modulation of the land.

The sketch for the intervention was black roofing paper laid out on the ground to define the line. The following day the paper was taken up and the line fertilized with a high-nitrogen fertilizer. This summer a distinct bright green line appeared across the pasture, marking the land in the stuff of the land itself. Year by year the line will gradually disappear and man's intervention will fade slowly away until the site is in its original state.□

Presto, Change-O: From Lobby to Rollerdome

M.I.T. leads the field in the number of its intercollegiate and intramural sports, but one activity which, until now, has lain at the bottom of the pack is roller skating. With no rollerdome within easy commuting distance, the aspiring roller figure skater could pass away without a trace. Leave it to the ingenuity of Barbara Wilson, '77, of Bedford, Texas, to convert the lobby of Building 7 into—presto, change-o—a skating rink.

Its hard, smooth surface providing little friction, Lobby 7 is a skater's dream with just one drawback—traffic and the litter it leaves behind. With most crossroads (three main corridors, one staircase, and an entranceway) leading to the lobby, Ms. Wilson can practice only after business hours. But on October 22, during the noon hour when the lobby is usually busiest, the Lobby 7 Committee invited her to perform without any interference from either trash or traffic.

"A person has to be a little bit dumb to be an excellent skater," says Barbara Ann Wilson, '77—"you have to keep from thinking too much, especially about the falls and how you might be hurt." But Ms. Wilson is not dumb. She's majoring in metallurgy and materials science, and roller figure skating—she's won some competitions in her home state of Texas—has become a hobby. Seeking a place to skate at M.I.T.—rinks are too far away, and too expensive—she settled on the Building 7 lobby after hours.

Accompanied by the title song from "Camelot," she held the attention of a large audience of passers-by throughout her performance, her graceful and fluid movements speaking for themselves. Whenever she performs, Ms. Wilson told Robert Dilorio of *Tech Talk*, she tries to show the spectators what skating looks like when done correctly and "with style. If I didn't feel I could do a move or a jump with style, I didn't do it."

A serious skater for 16 years, Ms. Wilson began skating under her parents' tutelage, both of whom taught roller figure skating, and subsequently rose from local to regional-level competition. While in high school, she helped teach skating classes at Skateland in Hurst, Texas, and would often practice four hours a day, seven days a week. However, at M.I.T. she finds herself in a dilemma—no rink within easy reach for her or her budget.

And what do people do when they see her practicing in the lobby? While a few mutter irritating remarks about roller derby queens, most just proceed on their business.□

M.I.T. Crew: Going After Harvard's "Head"

Walking through the Pierce Boathouse on the day of the Head-of-the-Charles Regatta (October 27) was like shopping in Filene's basement during the Christmas rush. Oarspeople were everywhere—most of them busily engaged in readying themselves and their boats for the grueling three-mile dash upstream; others who had already raced were happily intoxicated, unaware of the pain and fatigue and grateful that the "Head" was over for another year.

On that Sunday, more than 2,400 oarspeople (belonging to 111 organizations from as far away as Nebraska and Florida) took part in the largest one-day regatta in the world. Because so many participate, the regatta is treated most scientifically: Each boat attempts to beat the clock and the times of other entries, the clock being a PDP-10 computer system located in Waltham and the times remaining unknown until after each event.

Entries are started approximately ten seconds apart at the Boston University Boathouse, and 15 minutes is allotted

The Head-of-the-Charles Regatta can be both stunning and hazardous as these two photographs show: As the sun sets, its fading rays provide the perfect lighting for the romantic side of rowing; but prior to the end of a full day's racing, several boats, like this lightweight pair containing David Campanella, '76, at stroke, and Robert Sherrill, '75, in the bow, encountered navigational problems in the form of other entries (this one consisted of two Minneapolis oarsmen). (Photos: David H. Green, '75, from The Tech)

between events to allow for a clear course. The PDP-10 clocks each boat at both ends and calculates its time; but with almost 550 boats this year, the officials from the Cambridge Boat Club were kept busy, stopwatches in hand, in case the computer broke down.

Fortunately, everything functioned properly for this year's field—the largest ever. The M.I.T. Boat Club, represented in 11 of the 17 events, contributed its share to that record: Double and Novice Single Sculls (two oars per person), Pairs Without Coxswain (one oar per person), and both eight- and four-oared shells in the Junior, Intermediate, Women's, Lightweight, and Elite classifications.

Besides these entries, Gail Pierson, Visiting Associate Professor at the Sloan School of Management and a National Women's Rowing Champion, entered the Women's Singles event (she won), and Ted Van Dusen, S.M.'70, was in the Elite Lightweight Singles (he placed second). But because they rowed for the Cambridge and Riverside Boat Clubs, respectively, their accumulated points did not contribute to M.I.T.'s total toward the coveted Paul Revere Trophy for the highest overall point score by a school or organization.

When the day was over, the Tech crews found that they had successfully defended second place with 427.7 points to Harvard's 614.8—a position M.I.T. has held since 1970, when M.I.T. last won the Revere Trophy. (In 1971, Harvard was third, the Cambridge Boat Club receiving the honors.) Although none of the M.I.T. boats won its event, the Elite Four with John Everett, '76, and Gary Piantedosi, '76, two members of the 1974 U.S. National Team (*see December, 1974, pp. 109*) was edged out of first place by the Potomac Boat Club by 0.5 seconds—that's how precise the timing system is—an event won two years ago by M.I.T. *(see January, 1973, pp. 87-88).*

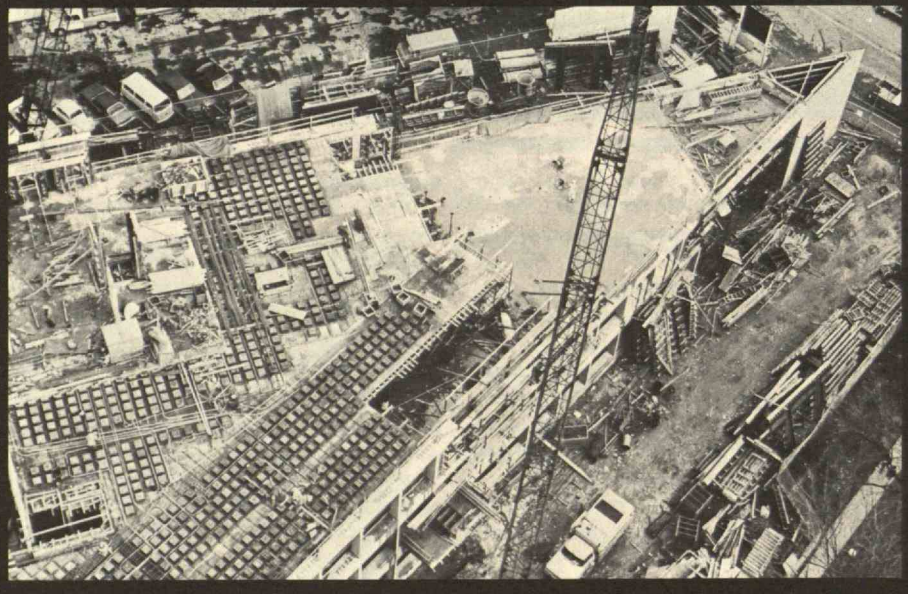
In the Lightweight Eights, the M.I.T. entry which lost to Princeton last year by 0.1 seconds took third place to Harvard and Rutgers, rowing in the "Howard W. Johnson"—also known as the "White Whale" *(see July/August, 1974, p. 95).* Other substantial M.I.T. finishes included a fifth place in the Elite Eights (won by the 1974 National Heavyweight Team with Everett), and seventh places in the Intermediate Eights and the Women's Eights (despite an untimely collision with another crew).

What's so special about the "Head"? In addition to its size, a unique point is that not only do the oarspeople require enough endurance to last through three miles (or roughly anywhere from 17 to 30 minutes) of hard rowing, but each coxswain must know how to steer the boat through an obstacle course of five bridges and torturous curves. Not exactly the most predictable body of water, the Charles River was choppy on October 27, with headwinds gusting up to 20 knots, upsetting the confidence of unwary crews.

But Peter A. Holland, Head Rowing Coach and Assistant Professor of Athletics, feels that the results were self-explanatory—M.I.T. has vastly improved in the last four years to keep up with the growing competitive field. Back then, M.I.T. won the Revere Trophy with only 304 points; this year the winning point score was twice that. As Coach Holland pointed out: "This year we had 24 boats entered compared to Harvard's 41. If you take that into consideration, you could say that, quantitatively, M.I.T. did much better than the winner." And quantitatively, that's what counts.□

The Gallery

Photographers' recent rambles (clockwise, around the page):
—Bicycles demand ingenious approaches to security. The Campus Patrol has reported the theft of a cycle's rear wheel while the front wheel and frame were secured by chain.
—The happy characters are in the cast of "My Fair Lady," the Musical Theater Guild's hit of the winter season.
—Not the prow of a concrete supertanker but construction on the chemical engineering building, its point targeted on Ames Street just north of the East Campus parallels.
—M.I.T. in the lead at Lime Rock's Car and Driver *Challenge Race; Joel C. Bradley, a graduate student in chemistry, finished third. (Photo: David A. Schaller, '78, from* The Tech*)*
—Count UMOC (Brian Hughes, '77) won the 1974 ugliest-man-on-campus contest. He's in the middle, with an unidentified runner-up on the right and President Jerome B. Wiesner (not a candidate) on the left. (Photo: Thomas F. Klimowicz, '77, from The Tech*)*
—Patricia M. Downey, one of the first Ida M. Green Fellows in the Graduate School, greets her benefactor at a luncheon in Mrs. Green's honor.



People

How M.I.T. Came to be "Special" for Women

M.I.T. is "a special place for women to be," says Betty Johnson, whose husband is Howard W. Johnson, Chairman of the Corporation. And, she adds, "women have added immeasurably to M.I.T.'s contributions in the last ten years."

Not one of the other three distinguished panelists—the wives of three other M.I.T. Presidents, speaking before the Women's Forum, the organization for women's affairs at the Institute, this fall—disagreed with her.

Indeed, Laya Wiesner (her husband is President Jerome B. Wiesner) proclaimed that "women have been beside and ahead of their husbands . . . for years." And she wants it to stay that way. Active in efforts to urge all women to consider careers in science and technology, Mrs. Wiesner is now considering how to assure that high school women have access to careers in non-traditional areas.

Catherine Stratton found her years in the President's House (her husband, Julius A. Stratton, '23, was President from 1959 to 1966) "the most fascinating in my whole life." And being M.I.T.'s first lady changed Margaret Compton's interests, too. While her husband, Karl T. Compton, was President, Mrs. Compton was instrumental in providing the first women's residence at 120 Bay State Road, and later she opened with Katharine D. McCormick, '04, the question of a permanent women's dormitory on the campus; those discussions led to the gifts which made possible McCormick Hall many years later.

M.I.T.'s first ladies may not be publicly identified with "women's liberation," but all of them are concerned with how women can be assured of broad educational and career opportunities, and all of them have helped improve the position of women at the Institute. Left to right, as they spoke to the Women's Forum, the organization for advancing the role of women at the Institute, this fall: Laya Wiesner, Margaret Compton, Catherine Stratton, and Betty Johnson. Dorothy E. Bowe (left), Assistant Director of Student Financial Aid, presided. (Photo: Michael Garcia, '78, from The Tech*).*

Piene: Toward a "New Visible Language"

Otto Piene, artist and writer who is Professor of Visual Design in the Department of Architecture, has been named to succeed Professor Emeritus Gyorgy Kepes as Director of the Center for Advanced Visual Studies.

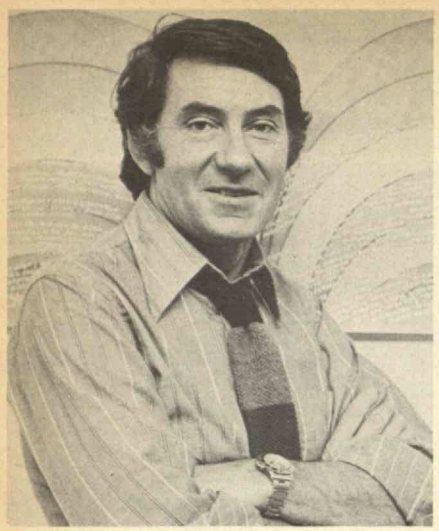
And Robert O. Preusser, Professor of Visual Design, is the Center's first Director of Education.

Professor Kepes, under whom the Center gained widespread national and international acclaim, becomes Director Emeritus; he will be a member of a new advisory group which will serve as a "visiting committee" to the Center.

Professor Piene, who was a Resident Fellow at the Center from 1968 to 1970 and a Non-Resident Fellow since then, was the co-founder (in 1957) of Group Zero, an assembly of international artists interested in kinetic, environmental, and elemental art. He has worked with great versatility in a broad range of disciplines, developing new painting and drawing techniques, designing light sculptures and murals for architectural commissions, and creating monumental pneumatic sculptures for public spaces. Among prominent examples of his work are his *Light Satellite* (Olympic Star) sculpture and the 1,600-foot *Rainbow*, both executed for the 1972 Munich Olympiad with M.I.T. collaborators that included Professors Walter Lewin and Harold E. Edgerton, Sc.D.'31.

Professor Piene has contributed to numerous international arts events and group and one-man shows. A definitive one-man retrospective of his work was presented at the Kunstverein in Cologne, Germany, in 1973, and an artistic profile of his diverse achievements will be sponsored by the M.I.T. Committee on the Visual Arts in a major exhibition in Hayden Gallery this spring.

Professor Piene plans to extend the Center's work in several new directions: seeking commissions for the Center's



Otto Piene

artists, exploring television techniques ("not just new toys, but new methods and new visual language"), investigating mixed media ("the interactions of sight and sound using musical and literary components"), and doing modest research to compile data on new techniques of interest to the Center's Fellows ("a means to the sharing of sophisticated information in the arts").

These new activities will not detract from but rather enhance the Center's traditional interest in art and technology for civic ends in a public role. "It is fair to state," thinks the new Director, "that in spite of the current fashionable trend toward private art, the possible integration of art and technology for the public good is neither dead nor undesirable for a lively future."

Professor Kepes is spending the current academic year at the American Academy in Rome; he is continuing painting and work on two writing projects (on light as a creative architectural medium and on public art), and later this year he will return to his native Hungary for an exhibition of his works in Budapest.□

Achievement Award

Morris Cohen, '33, Ford Professor of Materials Science and Engineering, holds the 1974 James R. Killian, Jr., Faculty Achievement Award. He is designated as James R. Killian Award Lecturer, and he will accordingly deliver one or more special lectures during the academic year. Though the lectures are expected to focus on his studies of the nation's materials problems and policies, the details and dates have not yet been announced.

Professor Cohen, who has spent his entire professional life at M.I.T., is cited for the Award as "one of the world's most distinguished living metallurgists." It recognizes his leadership of the National Academy of Sciences' Committee on the Survey of Materials Science and Engineering (COSMAT), whose final report is now in publication; his leadership in defining a new field of materials science and engineering and coupling into it his own field of physical metallurgy; and his contributions to physical metallurgy itself.

"The man and his work are held in the highest esteem in every industrial materials laboratory in the world. . . . (He is) ensured a place in the history of science."

Dr. Cohen first joined the faculty in 1938, a year after he completed his Sc.D. degree in metallurgy; he has been Ford Professor since 1962. Among many honors, he is a member of the National Academies of Science and of Engineering and is a past President of the American Society for Metals.□

Professor Morris Cohen, '33 (left)—"his place in the history of science is ensured" by his contributions to physical metallurgy and materials policy, said the citation—receives the $5,000 James R. Killian, Jr., Faculty Achievement Award from Professor Elias P. Gyftopoulos, Sc.D.'58, Chairman of the Faculty.

An M.I.T. Senior's Invention: Faster, Better X-Ray Films for Doctors and Clinics

Emanuel M. Sachs, '75, will graduate from M.I.T. in June with two degrees in mechanical engineering—S.B. and S.M. He will also take with him an automated X-ray film processor, the prototype model of which has already won acclaim for its promise to improve the quality of films available in doctors' offices and small health clinics.

Existing automatic film processors carry film on a tortuous path through processing tanks and washes. Mr. Sachs, whose project adviser is Woodie C. Flowers, Ph.D.'73, Assistant Professor of Mechanical Engineering, thought it could be done more easily and last year set about building a processor that moves film horizontally through tanks arranged in a single, straight line.

The result is a prototype that is small, reliable, and fast. X-ray plates developed in it are said to be "indistinguishable" from plates developed by hand.

Developing and fixing fluids in Sachs' design are separated only by rubber and Teflon rollers with stainless steel cores, which also propel the film through the system. They are the key to the design, molded by Sachs himself.

Mr. Sachs' work has been done under the auspices of the Undergraduate Research Opportunities Program with support of a scholarship fund established at the Institute by Clapp and Poliak, Inc., to aid students in the field of design engineering.□

Emanuel M. Sachs, '75, hopes to market his new X-ray film processor after he receives his M.I.T. degrees in mechanical engineering next June. Here he holds a micrometer to the plexiglas developer tank which he machined himself; Teflon and rubber rollers molded and cast by Mr. Sachs are the other key parts in the processor, which is small and simple enough to find a place in physicians' private offices.

Boston Biking: Sound Legs and Sooty Lungs

To Boston bicyclists, the automobile is a detestable creature, cutting them off at intersections, blowing out their eardrums, moving unpredictably, and—perhaps most annoying—enveloping them in clouds of noxious exhaust. Fed up—and also concerned about the quality of Boston's air—Beth Kleiner, '76, went on the offensive.

She spent last summer pedalling a bicycle equipped with an electronic carbon monoxide monitor on more than 200 excursions through Greater Boston.

On the average her monitor recorded carbon monoxide concentrations in excess of eight-hour limits set by the Environmental Protection Agency over most Boston streets and at most times of day. Indeed, the only place she found herself relatively free from the poisonous gas was on the bridges spanning the Charles River.

The carbon monoxide level, Ms. Kleiner found, depends heavily on weather conditions and the time of day. Windless days and rush hours are worst. So are shaded streets and areas of high-density residences, because cleansing winds are absent.

Ms. Kleiner reported particularly high levels on Massachusetts Avenue passing through the M.I.T. campus and at major intersections and squares in and around Cambridge. By comparison, she found lower carbon monoxide levels on such heavily travelled but spacious streets as Boston's Commonwealth Avenue. She recommends such streets to bicyclists, emphasizing that the only "safe" places are the Charles River bridges, free as they are of wind obstructions.

Ms. Kleiner continued her monitoring into the fall, in order to study the seasonal change in the carbon monoxide concentrations. It's sponsored by the New England Consortium on Environmental Protection and the M.I.T. Undergraduate Research Opportunities Program (U.R.O.P.).

The results have gone to the Massachusetts Department of Public Works (D.P.W.) to aid it in designing bicycle paths throughout the Boston area (the Federal Highway Administration recently granted $144 million of federal funds for state bicycle paths). Among those paths planned by the D.P.W. to run alongside existing roadways are a nine and one-half-mile route in Boston, Brookline, and Cambridge and a 14-mile path from Charlestown to Concord. Can they be located to avoid highest pollution? Perhaps, hopes Ms. Kleiner. And who knows—maybe one will be named the Beth Kleiner Trail.□

Bicycling in Boston is hazardous at best, and Beth Kleiner, '76, has found a new hazard. She spent the summer pedalling Boston streets with a carbon monoxide monitor, and most of the time she found CO concentrations between 10 and 25 p.p.m. Short-term averages often exceeded 70 p.p.m. By comparison, the Environmental Protection Agency has established that no one should be exposed to more than an average of 9 p.p.m. of CO over an eight-hour period or 35 p.p.m. for a one-hour period. Blood tests performed on a number of cyclists before and after trips through Boston confirmed Ms. Kleiner's findings that high CO levels plague the city's streets.

Management Problems—"The Same Everywhere"

Three months after Valery Tchouprikov, Deputy Head of the Laboratory of Composite Materials at the Baykov Institute of Metallurgy in Moscow, arrived at M.I.T., Susan Trausch of the *Boston Globe* talked with him and Mrs. Tchouprikov about being in the U.S. for the year in the Sloan Fellowship Program. Here are parts of her report:

"The stock market," Valery Tchouprikov said, closing his eyes and holding the space between them with his thumb and forefinger.

He was laughing, but he was hurting.

As one of this year's Sloan Fellows at M.I.T., he is attempting to understand the market and other American financial headaches, like accounting and inflation.

Most Americans don't understand that stuff. So you can imagine what it does to a Russian.

"Why do people invest in the market?" Tchouprikov asked, and a lot of shareholders are probably asking themselves the same question this year. As he talked he translated to his wife, Tamara, sitting next to him on a couch in a Sloan School conference room.

"The market is so unpredictable. All the buying and selling of shares. I can't figure it out.

"We have nothing comparable to it in Russia because there is no competition between businesses. We invest in cars and land and have bank accounts.

"Also, we don't worry so much about accounting in Russia. Our accounting offices are very small, routine places. Learning American accounting terms is almost like learning a new language—'tax loss,' 'carry-forward,' 'extraordinary item,' 'debentures'—it's impossible. Sometimes I study until one in the morning."

The 33-year-old metallurgist, who has spent the past five years as Deputy Head of Moscow's Laboratory of Composite Materials at the Baykov Institute of Metallurgy, is the third person to join the Sloan program from the U.S.S.R.

An informal exchange program has existed between Moscow and Cambridge since the mid-1960s when several M.I.T.

professors met with a director of Russia's State Committee of Science and Technology. Through that meeting, Russians began applying to the Sloan program and Sloan fellows began visiting factories and industrial sites in the U.S.S.R.

Dr. Tchouprikov continued. "But now I like the challenge. Also, I feel that managing is really a science, too—a science of people."

Dr. Tchouprikov, who arrived here in the summer, is now taking eight courses, including organizational psychology, finance, marketing, international economics, American law, quantitative analysis and systems dynamics. In the systems dynamics course he is involved in a world game. "We are all making a mess of things," he says.

Tchouprikov hopes to write his thesis on some aspect of international law and would like to work with the United Nations eventually.□

To Keep Up With the Navy, Live on Board

Maintaining the three boats in M.I.T.'s "navy" in seaworthy condition at all times keeps Captain Rodney Swift close to the 50-ft. Robert R. Shrock*: He lives on board. The* Shrock *and two 16-ft. Boston Whalers are used for oceanographic studies—and for other Institute purposes, academic and otherwise.*

When Rodney Swift came to M.I.T. 15 months ago, he thought he was in charge of only a single vessel—the 50-ft. oceanographic ship *Robert R. Shrock.* But now the M.I.T. "navy" has grown to three (two 16-ft. Boston Whalers have been added), and the end is not in sight.

There are hopes of a new flagship—a larger, steel-hulled vessel whose size and strength would permit overnight operations along the continental shelf. Both accommodations and design limit the *Shrock*'s usefulness.

The *Shrock* began service for the M.I.T. Department of Earth and Planetary Science; now she's been transferred to the Sea Grant Program, where the three boats operate under the guidance of a faculty Research Vessel Management Committee. All three are available for charter by M.I.T. groups "for any Institute purpose, academic or otherwise."

Formerly berthed at Lewis Wharf in Boston, the M.I.T. "navy" has now been

moved to a pier at the New England Aquarium on Atlantic Ave. in Boston. A better berth, thinks Captain Swift—especially since the *Shrock* is now being used on some joint M.I.T.-Aquarium programs.□

Four New Faces at the Alumni Association

Four appointments have been announced to complete the staff of the Alumni Association for 1974-75:

—**Ronald S. Stone**, '59, formerly Assistant Dean and Executive Officer of the M.I.T. Graduate School, is Associate Director of the Alumni Fund.

—**Daniel J. Fingerman**, '69, has come from a post in the College of Education at Michigan State University to be Assistant Director of the Alumni Fund.

—**Stephen E. Barnes**, 74, has been named Director for Special Events of the Alumni Association.

—**Ena Squires**, formerly Administrative Assistant in the Department of Architecture, is Assistant to the Director of the Alumni Fund.

Two of the four posts—those occupied by Mr. Barnes and Ms. Squires—are new, and they represent extensions of M.I.T. alumni activity. Mr. Barnes will coordinate and manage a series of 12 regional conferences scheduled for 1975 and 1976 in as many of the nation's major cities. Ms. Squires' appointment is designed to strengthen the management of the Alumni Fund so that other members of its staff can concentrate more fully on special and regional projects.

Mr. Stone joined the M.I.T. Graduate School in 1970, having for the previous four years been associated with the Institute's Industrial Liaison Office. His undergraduate degree was in chemistry; he holds a master's degree in that field from the University of Vermont and has completed further advanced studies in physical and nuclear chemistry at the University of California (Berkeley).

Following his graduation from M.I.T. (his undergraduate studies were concentrated in mathematics, psychology, and education), Mr. Fingerman served two years with the Peace Corps in Malaysia and then returned to study sociology and psychology at Michigan State University where he received his M.A. in July. He holds a Karl Taylor Compton Award (1969) for leadership as an M.I.T. undergraduate.

Ms. Squires is a native of Grenada, and following school there and in London she held positions with the Grenada Public Library, the British firm of Jonas Browne and Hubbard, Ltd., and the Grenada National Bank, and the Spice Island Inn. She was with the First National Bank of Boston in 1968 and 1969 and came to M.I.T. in 1971 to be Administrative Assistant to the Executive Officer of the Department of Architecture.

Mr. Barnes' undergraduate degree is in the field of naval architecture and marine engineering, and in his junior and senior years he held a scholarship of the Society of Naval Architects and Marine Engineers; he is a member of Phi Eta Sigma and was elected to Tau Beta Pi during his senior year. Before entering the Institute Mr. Barnes studied for one year at the University of Illinois, worked for two years in industry, and served for 18 months in the U.S. Navy.□

Bradley Dewey, 1887-1974

Bradley Dewey, '09, a distinguished chemical engineer and industrialist who had been a member of the M.I.T. Corporation for 43 years and an active alumnus almost since his graduation, died at his home in New London, N.H., on October 14. He was 87.

In terms of years of continuous service, Mr. Dewey was the oldest active member of the M.I.T. Corporation, and he counted his service to the Institute among his important achievements. He first joined the Corporation when he became President of the Alumni Association in 1931, and he was elected a Life Member five years later; his 43 years on the Corporation made him the fifth longest tenured Corporation member since the founding of the Institute.

In that 43-year period, Mr. Dewey served on 14 of the Corporation Visiting Committees and chaired seven of them; he also served on the Auditing and Membership Committees. Mr. Dewey was a strong advocate of management education for chemical engineers, and his ideas played important roles in the development of curricula in both chemical engineering and management. He was made a member of the Advisory Council of the School of Industrial Management when it was founded.

Howard W. Johnson, Chairman of the Corporation, said Mr. Dewey's continuing interest "in the life and development of M.I.T. was a source of unflagging strength. He was widely known for his readiness to offer constructive criticism regardless of the situation, and this quality was an immeasurable asset to the Institute."

Mr. Dewey's father, Davis R. Dewey, was a distinguished economist, a member of the M.I.T. faculty from 1886 until his death in 1942; the Dewey Library of Economics and Social Science is named in his honor. It was from his father that young Bradley learned the importance of understanding economics and management as part of preparation for an engineering career.

Eight years after he graduated from M.I.T., Bradley Dewey found himself in the U.S. Army Chemical Warfare Service with a friend from his M.I.T. student days, the late Charles Almy, '10. The result was the founding in 1919 of the Dewey and Almy Chemical Co. in Cambridge to provide chemical and engineering services to industry—in which Mr. Dewey, as President, became a leading expert in natural and synthetic rubber products. After World War II the firm moved into plastics and food freezing and in 1954 was acquired by W. R. Grace and Co.

Thereafter, Mr. Dewey, relieved of his responsibilities for the Dewey and Almy Chemical Co., acquired U.S. rights to a European process for manufacturing plastic tubing and formed the Bradley Container Corp. in 1954. When it was sold three years later, the indefatigable entrepreneur began once more—with the Hampshire Chemical Co., sold in 1958 to W. R. Grace and Co.

A native of Burlington, Vt., Mr. Dewey studied for three years at Harvard and then came to M.I.T. for his S.B. in chemical engineering. He was President of the American Chemical Society in 1946 and a leader as well in other professional societies, and he won the Medal of the Society of the Chemical Industry in 1944. He held honorary degrees from the University of Akron (1944) and Northeastern and Harvard Universities (1945), and he was active in community affairs in Cambridge and more recently in New Hampshire.□

James G. Cronin, 1913-1974

James G. Cronin, Administrative Assistant in the Comptroller's Accounting Office who was also Chairman of the Credit Committee of the M.I.T. Employees' Federal Credit Union, died on September 8. He came to the Institute in 1943 to help manage the Naval Radar Training School, and he had served with the Dynamic Analysis and Control Laboratory after World War II before joining the Accounting Office.

Deceased

Philip B. Rice, '03; May 17, 1974
Bradley Dewey, '09; October 14, 1974
James R. Stevenson, '10; January 7, 1974
Theo O. Hotard, '12; December 25, 1973
Gabriel Harris, '14; August 9, 1974*
Samuel S. Otis, '15; July 1974*
Dudley E. Bell, '17; November 26, 1974
Harry A. Kuljian, '19; November 5, 1974*
Robert F. Lewis, '19; September 4, 1974
Harmon B. Deal, '20; February 5, 1974*
Ellsworth V. Holden, '20; September 2, 1974*
Tom T. Freeman, '22; September 20, 1974*
H. Clifford Gayley, '22; October 22, 1974
Fullerton D. Webster, '22; October 26, 1974
Boyd E. Oliver, '24, October 1, 1974*
Harry P. Henderson, '25, March 16, 1973*
Cecil C. Marble, '25; December 21, 1973
Rufus S. Wilson, Jr., '26; October 29, 1974
Archie C. Higgins, '27; November 18, 1970
Edwin H. Himrod, '27; October 5, 1971
Donald S. Fraser, '28; October 11, 1974
George M. Houston, '30; August 25, 1974
Bernard Rubinstein, '33, November 21, 1972
Henry F. Gray, '38; August 11, 1974
Richard B. Lawrance, '40; July 26, 1974*
Charles K. Raynsford, '42; December 14, 1973
Robert H. Millett, '50; October 11, 1974*
Lawrence Strickland, '52, November 2, 1973
*Further information in *Class Review*

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Congratulations will be due **Richard O. Elliot** on February 6 when he will celebrate his birthday—number 102! His daughter reports that his interests are chiefly in things historical—especially those dealing with shipbuilding or Maine.—**Clare Driscoll**, Acting Secretary, Cliff Street, Plymouth, Mass. 02360

09

Just at the time that the December class notes were due the notice of the death of **Bradley Dewey** on October 14 in New London, N.H., at the age of 87, was received. Only a brief notice then was possible. His career is so replete with accomplishments and high honors that space permits just the citation of the most important ones. He was born in Burlington, Vt., August 23, 1887, attended the Volkman School, Boston, and in three years graduated from Harvard University with the bachelor's degree in 1908. He entered the Institute to study chemical engineering, receiving his S.B. in 1909. Upon graduation from M.I.T. he joined the American Sheet and Tin Plate Company where he formed a small research organization which became incorporated into U.S. Steel. In 1917 he entered the Army as a captain and rose to colonel and commander of the Gas Defense Division of the Chemical Warfare Service. He was the Army's youngest full colonel. During 1917-1919 he and another chemical engineer, Charles Almy, '10, supervised the design and mass production of gas masks for which Brad received the Distinguished Service Medal. At the conclusion of World War I, he and Charles Almy formed the Dewey & Almy Chemical Company of Cambridge. A major problem in the industry was the lack of a safe sealant for the tops and bottoms of tin cans. In 1921 Brad discovered a latex sealing compound which for many years was the company's principal business. The company of which John F. Davis, a classmate, was president, mass produced the first machinery for applying the sealant. In 1939 Brad's company, under his direction, developed a synthetic rubber and then constructed a synthetic rubber plant which, when completed in 1942, became one of the first privately built and operated synthetic rubber plants in the eastern United States. Because of his expertise with synthetic rubber Brad became Deputy Rubber Director of the War Production Board during World War II and under his leadership the development of a synthetic rubber industry was completed in record time. At the conclusion of the war he returned to his company and from his research came plastic bags in which foods are sealed and frozen for marketing. This process became the basis of the company's CYROVAC Division. In 1954 Dewey and Almy Chemical Company was acquired by W. R. Grace and Co. in which he served as director until 1960 when he became emeritus director. He then formed the Bradley Container Corp. and began the manufacture of plastic containers for everything from food to health care and beauty products.

Brad was the son of Davis Dewey, famed Professor of Economics at M.I.T. and for whom the Institute's Library of Economics and Social Science is named. Many of us '09ers took his course in "Polycon". In addition to being most active in 1909 class affairs, Brad served 43 continuous years on the M.I.T. Corporation making him the fifth longest tenured Corporation member since the founding of the Institute. He served on many committees including the Auditing Committee and several Visiting Committees. He was elected the 38th President of the Alumni Association and later was made a life member. In World War II he was a member of the Guided Missiles Committee and was an active observer at the atomic bomb tests at Bikini Atoll in the Pacific. He was a long time member of the American Chemical Society and its president in 1946. Among his many honors were the Medal of the Society of the Chemical Industry and honorary doctors' degrees from the Universities of Akron, Northeastern and Harvard. Survivors include three children, Dr. Bradley Dewey, Jr. of Hanover, N. H.; Mrs. Douglas G. Carroll, Jr., of Baltimore, Md.; Mrs. S. Leonard Kemp, III, of Andover, Mass., 16 grandchildren and five great grandchildren. His wife, the former Marguerite Mellon of Chicago whom he married in 1915, died last June. Another son, Dr. Davis R. Dewey died in 1972. Both sons were students in the electrical courses given at Harvard by your class secretary. Funeral services were held at St.

Alice Curtis Desmond Photographs and Books

The late Thomas C. Desmond, '09, brought distinction to his alma mater as a successful contractor and, for 28 years, as a member of the New York State Senate. Now his wife, the former Alice Curtis, has brought to the Institute a small sample of her wide-ranging talents through an exhibition of 68 photographs and a complete set of her 20 books.

Both books and photographs were shown during November at the M.I.T. Faculty Club, and the books are now part of the M.I.T. Libraries.

Mrs. Desmond's books are devoted to travel and historical subjects; the most recent was *Cleopatra's Children*, an historical study published in 1971. *Far Horisons* (1931)and *South American Adventures* (1934) were endorsed by the Carnegie Endowment for International Peace and distributed to Carnegie libraries to promote international good will. *Jorge's Journey* (1942), a children's book, was translated into Portuguese by the Brazilian coffee industry and distributed throughout the schools of Brazil. The National League of American Pen Women identified *The Talking Tree* as the best juvenile book published in 1949. Other historical subjects have included Martha Washington, Dolly Madison, and the wives of Napoleon Bonaparte and Alexander Hamilton.

While researching and writing books, Mrs. Desmond has also traveled the world to make photographs which have brought her both distinction and prizes. She won the George Eastman Silver Medal at the 11th Focus Salon in Amsterdam in 1951, and she holds awards of merit from the Photography Society of America and countless other exhibitions.

Photographs shown at the Faculty Club included black-and-white and color images from three continents. There were pictures of familiar tourist sights in the U.S., of African wildlife and landscapes, and of aspects of Paris.

Mrs. Desmond was unable to attend a preview of her photographs and books on November 1 at the Faculty Club. Indeed, her achievements are the more remarkable for having been made during many years of painful chronic illness.

Andrew's Church, New London. On behalf of the class a letter of sympathy was sent to Bradley, Jr., and, as was suggested, a contribution to the New London Hospital.

We have received from Mrs. **Andrew L. Matte** of Yorktown Heights, N.Y., a notice of the death of her husband on October 3 after a very long illness. Andrew was born September 15, 1886, and prepared at Drury Academy. At the Institute he was in Course VI and a member of the Electrical Engineering Society. In 1912 after graduating he returned for graduate work. In 1918, after five years with the Detroit United Railways, he joined the American Telephone and Telegraph Company, transferring to the Bell Telephone Laboratories with the department of development and research. His work was concerned with carrier telegraph systems in which he held 19 patents. He was recognized as an authority in this field and was called into consultation by the government and various railroads. He was the author of several technical papers and received an American Institute of Electrical Engineers first prize for best paper in the field of engineering practice, "Frequency Shift". The subject of the paper was widely used during World War II. On retiring from the Bell Telephone Laboratories in 1954 he became Associate Professor of Electrical Engineering at Polytechnic Institute of Brooklyn. He was a life member of the American Institute of Electrical and Electronic Engineers, honorary member of Eta Kappa Nu, and listed in American Men of Science. He leaves his wife, the former Anna R. Greene, a nephew, Joseph Matte, and two nieces, Miss Pauline and Miss Marie Matte. The secretary has written to Mrs. Matte expressing the sympathy of the class as well as his own.

For the information of the class, our balance in the Cambridge Savings Bank as of September 10, 1974, was $1,545.13. Expenses during the past few years have been light with small amounts for reunions and memorial contributions. Interest accrues at about $75.00 per year.—**Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

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Joseph N. French writes: "Retired from Albert Kahn Associated Architects in 1967 after 51½ years; now work around the house and in the garden. I belong to a retired mens club, Masonic Orders up to 32nd Degrees, and St. Pauls Church.—M. L.

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A Happy New Year to you all! I suggest that among your resolutions you include a promise to send me one or two letters or notes during the year.

Wally Murray writes from his new home in Gorman, Maine that he took a two weeks trip in March with friends to Mexico and had planned a trip to the Near East with the same group last fall. He was forced to abandon it, however, due to a prostate operation. He attends almost all meetings of the M.I.T. Club of Western Maine which he says is an active one. . . . **Larry Cummings** and Julie write from Indiana that they are in reasonably good health. They spent the month of July, as usual, at the cottage on Squam Lake, N.H. where they enjoy the boating and fishing. Another of their grandchildren is to be married next spring. They now have two great grandchildren—a four year old boy and a baby. Larry still plays golf once or twice a week, but finds his game is slipping. The Cummings did not take their usual western trip this year, but drove to southwestern Indiana to visit the so-called "Angel Mounds" near Evansville. Julie writes they also made a historical trip to southern Indiana and saw the old Governor's Mansion and the James Clark Memorial (whatever that is). Excellent foliage this year.

A clipping from the *Boston Globe* tells about **Joe Champagne** and Libby: "Just Waltzing Through. A bit of the past waltzed into town this week, then settled briefly to chat before taking off to winter on the Costa del Sol in Spain. Joe, a courtly and lively 84, and lovely Libby, are remembered for writing and dancing "The Champagne Waltz" in 1935 and for their performances at local hotels, chiefly the Copley Plaza. Pre-World War II debutantes would prepare for their cotillion waltzes with the Champagnes. Joe was a mining engineer graduate but never practised engineering. He said, 'I realized there was more gold in dancing. While in Spain this winter the Champagnes plan to write a book about their travels and the celebrities they have met like Rudy Vallee and Duchin. They return in May to celebrate their 50th anniversary."

We regret to report the death of **Dolphe Martin**, which occurred in Boston on October 2 after a brief illness. He graduated from Harvard with a medical degree in psychiatry followed by a special course in our class. He successfully combined music with psychiatry in the treatment of mental patients. He also received a special degree in music from the Ecole Cesar Franck in Paris with excellence in conducting and composing. He continued his musical work in Europe and has written a book, *Poetry is Good Medicine*, which will shortly be published. He is survived by two daughters, Ruth and Eileen of Roslindale, Mass. Our sympathy to them.—**Ray E. Wilson**, Secretary, 304 Park Ave., Swarthmore, Penn. 19081

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A list, dated last May, of students admitted to the Institute in 1974 includes the name of Armando Garza Sada, a grandnephew of our late classmate **Eugenio Garza Sada**. The list shows five other M.I.T. alumni of the Garza Sada family, including Armando's father and grandfather.

An October note from **Bert Hadley** reads, "After 21 years as President of Sporting Arms and Ammunition Manufacturers Institute, I resigned and was elected Honorary Chairman." . . . **Harold Mayer** wrote late in October that he had moved to Milwaukee, to be near his son, a recent graduate in medicine, and his daughter-in-law. Harold likes it there, and enjoys being only three blocks from the library, which he finds remarkably good. He goes there every day, and is still working on German. His new address is 1226 West Wisconsin Ave., Milwaukee, Wisc. 52233.

Alden Waitt has sent me a long letter of delightful reminiscences of his younger days, beginning with summers in the same area in Maine to which **Leicester Hamilton** went (and still does). Alden mentioned his trips on the spic-and-span launch that Ham's father owned, and an expedition on a smelly fishing boat that turned out unfortunately for Alden. In answer to my question, he confirmed that four members of our class graduated from Medford High School. Besides Alden and Ham, they were **Harold Richmond** and **Starr Stanyan**, neither of whom is any longer with us. Alden's letter continues, "All four of us were active in high school. Ham was most interested in the high school battalion and became Battalion Commander. As I remember it, Harold was a Company Commander. I don't know about Starr, but I who was generally in some disciplinary difficulty, ended up in my senior year as Color Sergeant. I think all four of us were in the Medford High School Congress, a debating society modeled on the U.S. Congress. Ham was the more athletic of the four and also wrote for the high school magazine. Harold had a crystal set and communicated by Morse Code at considerable distance for those days. I wasn't big enough for baseball or football but did practice with the hockey team and finally was put in as goalie long enough to get my letter and allow in the only goal made by our opponents who lost the game and the suburban league championship which we won that year. Ham will insist that I was always lucky. You know how Ham became commander of the M.I.T. Regiment and of Harold's activities. You may not have known that I got excused from military drill because of physical disability. My family doctor was finally convinced after some argument that my weak constitution wouldn't permit so much activity. I wasn't able to get out of gym. Doc, wouldn't go that far. And after floundering around for a while I finally ended up in the army in spite of a weak constitution. A ward of the government."

It would be interesting to know if as many as four of us came from any other school.

The Alumni Association reports the death of **Gabriel Harris** on 9 August 1974. There were no details, and the class records show only that he was with us in our freshman year, was in Course III, had lived in Brockton and in Centerville, and in recent years had a home in Miami.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

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Happy New Year! With the hope that you and your families have all enjoyed a pleasant holiday season. Another reason to be The Class Supreme, on October 18 at The M.I.T. Faculty Club here, 21 classmates, ladies and guests met for our regular class luncheon. At the last minute Kath Howlett and Ethel Rooney could not come, but we welcomed Lucy Murphy, Bee Norton, Elsie Guptill (with Dinger Doane) and our genial hostess, Barbara Thomas who served as bar maid and did a good job at it.

Again, the long distance men won top honors—**John Dalton**, Providence; **Bill Brackett** (on crutches) Duxbury; **Larry Quirk**, Middletown, Conn.; **Stan Osborn**, East Hartford, Conn.; **Jack Dalton** and **Pop Wood**, Peterborough, N.H.; **Evers Burtner**, Kingston, N.H.; **Charlie Norton**, Vineyard Haven, Mass.; **Max Woythaler**, Framingham; **Archie Morrison** and **Fred Waters**, Swampscott. The rest of us were **Dinger**

Doane, Herb Eisenberg, '52, (Sam's son), Bob Bailey, '41, (Larry's son), **Horatio Lamson**, **Harry Murphy**, **Wally Pike** and me! **Wayne Bradley** phoned from Moosup, Conn. A fine showing by a group of fine friends. We missed our regular old attendees who have died recently, but it's good to see the sons of some of these deceased classmates interested in joining with us and we welcome them. **Jack Dalton** closed the meeting with a tribute to the clans loyalty and spirit and his own pride and pleasure at being our class president. Nice going Jack, we always like to hear you. . . . The Annual Trek of the "snow birds" to the alleged sunny south is on. **Larry Landers**, now recovered from his recent severe heart surgery led the birds in November, followed by **Jack Dalton** and **Max Woythaler** to various Florida hide-outs; soon, **Jim Tobey** will be suffering down there with them. Ah, me!

Clive Lacy has recovered successfully from a bout with severe surgery. Our best to Clive for continued good health. . . . **Louie Young** has our sympathy for his continued slow recovery from his hospitalization. All the best, Louie! . . . You'll be hearing from Joyce Brado in Lockport, N.Y. who is carrying on as our class agent for **Ben Neal**. Keep up your good work, Joyce. We're all for you. . . . **Phil Alger** sent me a reprint from the September 1974 issue—"I.E.E.E. Power Engineering Society"—of his response to their award to him at their 1974 summer meeting. In his "Ethics and Politics", Phil gave a very learned talk.

Samuel S. Otis died in July, 1974 in Chicago. . . . That old familiar wail rings out again—"help Azel" with some news about yourselves.—**Azel W. Mack**, 100 Memorial Drive, Cambridge, Mass. 02142

16

As we enter 1975, which is the 80th year or more for all of us and our 59th since graduation, we might get some inspiration from our classmate, **J. Spotts McDowell**, who writes, "I have indeed completed my first ninety years. While slightly battle scarred, I am still in fairly good physical condition. I keep busy with matters of no interest to anyone except myself, and the time passes much too swiftly. The days aren't long enough!" . . . We're still catching up on correspondence received in the summer and early fall. **Merrick Monroe** up in Harrison, Maine for the summer from home in Noroton, Conn. notes that he remembers "Looking ahead to my four years in high school, and wondering how there could be so much time to come—Now I look back wondering where it went to and how so fast!" His wife, Miriam, say she is "Hoping for that feeling of leisure and contentment to make me turn to my mother's paint box. She took up painting at 76 and was really quite remarkable with her color memory of New England Landscapes." . . . **Bob Burnap** of So. Orange, N.J. writes he had little news to report but "I suppose the fact that I am still reasonably healthy and have no catastrophes to report is news of sort." He indicates that he and Katherine do not travel very far from home by car but might be tempted to visit our secretary at Mountain Lakes.

Ken Sully writes from Laguna Hills that their "Leisure World" has 23 courts and three pools, so they shuffleboard and swim three days a week, and that they "have been to several Southern Orange County M.I.T. Luncheons and recently had Kay (Mrs. Irving B.) McDaniel with us. We're taking our first trip to Yosemite and the Ahwahnee." . . . **Hank Smith** of Leisure Village in Lakewood, N.J. says things are pretty quiet for him "particularly since I'm living alone following the long incapacity and passing of my wife Dorothy in '72. Some bowling, bridge, shuffleboard, pool swimming and local affairs sponsored by the Village constitute our activities for the most part. Health continues to be very good, and I hit 82 in November." . . . **"J. H." Murdough** of Lubbock, Texas offers this toast for the class: "May the next year, my 82nd, find us all cheerful and happy and as free from 'aches and pains' as can be." Then he adds, "We came out to this new country, new college, in 1925, and found very satisfying work with what is now called Texas Tech University. It was quite a change for a native of 'The home of the bean and the cod' to the high plains, but the longer we live here the better we like it. Certainly, there is plenty of sunshine for 'old folks'." . . . **Dave Patten** of Duxbury, taking advantage of a warm spell, said he and Dorothy "went to Maine in May for three days of early trout fishing before the black flies started their rampage. No flies and no fish to amount to anything, but a good visit with my cousin and wife who have retired to the old family home in Cherryfield. Prior to this we flew down to Washington a couple of times for visits with Dorothy's two sons. The youngest one, now a Major General in the Air Force, was decorated with the D.S.M. In addition, there are still quite a few old friends from our war-time residence there. However, the list gets smaller as the years fly by, one of our great losses being General Spartz."

Ted Parsons kept us posted with this note, "After seven years of life in Pennsylvania, just a few miles west of Valley Forge, a place chosen to be near our daughter, her husband and two children, we have all moved to Thetford Hill, Vermont, just a bit over one year ago and find it wholly different, but which meets our requirements just as well. We all live in a double house, with a separate apartment for my wife and myself, the larger apartment for the others, both families well satisfied with the arrangement. Gladys and I are not in the best of health and find the lessened amount of housekeeping more in accord with our present needs. The countryside hereabouts is beautiful. The full length of the Franconia Range is just across the Connecticut River and it gives a magnificent view, of which we never tire. Routes 5, 89 and 9 are within immediate access and run largely in a north-south direction. The traffic thereon is infinitesimal, in comparison to that on the main roads west of Philadelphia and driving is with a much greater degree of pleasure in consequence. Further than that, the scenery hereabouts is beautifully changing all of the time, day to day, week to week and month to month. In the autumn the display of color changes in the maple and other trees is an astounding attraction to many thousands of those who come to this part of the country for no other reason. Winter, too, lures those to whom skiing and winter sports are a major attraction. From our balcony windows we can see the five ski slides which belong to the Dartmouth Club and, with glasses, we can follow their activities easily. Sure, it is cold in the winter at times! Last year the thermometer registered −28° F. for a few days and guarding against these low temperatures is quite necessary in all outdoor sports. We are beyond such sports, but we have a car which hasn't refused winter use and we get about as the need arises. Deer show themselves in our backyard at times and they take no harm at our hands. All in all, we like it here." . . .

A comment from **Tom McSweeney**, "I dare not look behind—something is catching up! Could it be old age?" . . . **Walter Wolfe** wrote in early September: "I am 80 now and in good health. The other afternoon I was getting a haircut and I said to the barber, whom I had known for a long time, 'John, I have a birthday tomorrow. I'll be 80 years old'. John then announced loudly, 'The Colonel will be 80 years old tomorrow. How about that!' The three barbers and several customers all congratulated me. It was an impromptu birthday party of sorts—things like that can happen only in a small town." . . . From **Nat Warshaw**: "Thank you for writing and sending the reunion picture and highlights of the 'Bull' session. Too bad all of those who came down did not get in the picture. Yesterday I attended the 57th reunion of my artillery regiment. Same story—too few showed. It was great to see those who did come. We have a reunion every year also. Take good care of yourself and will see you next year."

Charlie Lawrance and his wife Lois, commenting on our 58th Reunion, expressed their joy "to feel the warmth of friendship revived at their meeting of precious companions along the pathways of Auld Lang Syne. Each year they become more precious in memory and keep the spirit looking forward to the next great events of our lives. Our best wishes for your good health and happiness and through you to every living member of our M.I.T. Class. We have just returned from Indiana to be present at the wedding of our grandson (and my namesake) to a beautiful Hoosier girl both now settled in Muncie, Indiana." . . . **Hy Ullian** remembering our 58th wrote of "the pleasant reunion at the Cape and its opportunity of seeing several of our classmates. The photograph of those in attendance was excellent and will be looked at over the years to see if any of us grow younger. Frieda and I are looking forward to next year with hopes that we are all well". . . . We had a nice letter from **Theron Curtis** and are happy to report that he and Hope celebrated their 60th Wedding Anniversary in September. Congratulations and best wishes for many more.

With regret, we report the deaths of four of our classmates. Mrs. **Talbot Flanders** writes: "Talbot died a year ago Decoration Day. The one time he was able to get to the reunion at the Cape meant a great deal to him." . . . Mrs. **Thomas Raymond** writes: "My husband passed away the last of August. We were both sorry we were unable to attend the reunions of the 1916 Class. He was the best golfer in Zanesville and has the large cup from our Country Club. He had many hobbies. He played the organ and accordian beautifully." Tom was founder and president of Simplex Engineering Company and a well-known professional engineer in Zanesville, Ohio. . . . Also, **Fred C. Holbrook**, long-time owner and operator of Scott Farm, a large apple growing business in Brattleboro, Vermont, died in October. After brief service as a second lieutenant of artil-

lery in France in the last days of World War I he returned to Brattleboro to manage the apple farm rather than resume his career in civil engineering. He remained in charge of the apple-growing operation until his son, Frederick, took over after the Korean War. Mr. Holbrook's home in Brattleboro was "Maulahka", the mansion in which author Rudyard Kipling lived and wrote for several years. . . . And finally, our very able Assistant Secretary, **Len Stone**, passed away on October 29. Len had been ailing for several months and for the first time in many, many years he and Dolly were forced to miss our Annual Reunion at Chatham last June.

Harold Dodge, to whom we are greatly indebted for his long and devoted service to our class, has requested a leave of absence from his responsibility as secretary. We will surely miss his major effort in the preparation of our class notes and the many ways he has kept our classmates together. . . . Keep your letters coming with bits of news and philosophy.—**Ralph A. Fletcher**, Acting Secretary, West Chelmsford, Mass. 01863

17

An anonymous contributor writes: "The painting of M.I.T.'s historic Rogers Building is a memorial gift by widows of members of the Class of 1917, given on the occasion of the 50th Reunion of the class. It was painted by **Nelson Chase**, who served on M.I.T.'s Architectual faculty in Rogers from 1919 to 1932."

So reads the new placard placed beside the painting in its new location at the entrance to the main collection of M.I.T. historical material. With special quarters allotted recently at 265 Massachusetts Avenue, Cambridge, the irreplaceable portraits, photographs, paintings, drawings and miscellaneous memorabilia have been gathered from attics, cellars, dirty shelves and from President's outer office, to make a museum fascinating to anyone, and intriguing indeed to alumni who have seen so much of history made.

"Solely as a small art museum, the collection has two Rembrandt Peale beauties, six or eight Woodbury oils so modern they might have been painted in the last decade, a portrait group of outstanding quality, by diverse artists, and a miscellany of art objects of more tenuous tie to M.I.T. but in themselves worth attention. On a recent visit **Nelson Chase**, invited with **Jim Flaherty** to view his painting in its new setting, found several of his own early works hung in the architectural section. The two course IV men spent much of their time looking through the large collection of early drawings by men in the Department, John Taylor Arms, Wells Bosworth, Sam Chamberlain, Despradelle and many others who later achieved international recognition. Theirs was the first school of architecture in the United States.

"The Class of 1917 has adequate representation, thanks to Nelson Chase and others. In a case housing the Wedgewood group of M.I.T. dinner plates is a china platter, one of adequate size, incorporating the glazed but smiling, life-sized face of **Harold E. Lobdell**. On the lower rim runs the inscription "Del M.I.T. Club de Monterey para Lobby con un saluda- Mazo 11 de 1952". It is a fitting location, for it will be remembered that Lobby promoted the distribution of the Wedgewood plates as a subsidiary activity for his *Technology Review*. The platter was found at the bottom of other memento matter gathering dust in an odd corner and retrieved by the staff of Warren Seamans, Director of the Committee for Historical Collections. Conchita Lobdell Pearson was advised of the find and graciously approved its present placement.

"Chase and Flaherty were pleased, impressed, and ready to give hearty endorsement to a program for more substantial support for the too long neglected proper preservation and display of such interesting historical material as they saw."

The foregoing anonymous contribution is gratefully acknowledged. The collection is of such interest and value that your secretary feels his visit should be reported and in the first person. Having learned that our Rogers painting had been transferred to "an historical exhibit" my curiosity was aroused as to its place and showing. I went to spend 15 to 20 minutes and stayed 2 hours. The varied exhibits and collections were fascinating. The portraits are a show and aroused a good feeling on walking into one room to be confronted by the likenesses of Doc Talbot, Doc Dewey, Harry Tyler and others. The samples of the developing electronic industry were many. Class records, course records, personnel records, all sorts of records were impressive. The 1917 file has been brought up to date with copies of our reunion notices and reports, starting with our 10th. The location of our Rogers painting is perfect. I had forgotten what a truly lovely painting it is. The detail of the building is so exact and the frieze depicting the early courses at the Institute, civil, mechanical, mining and architecture, reveal Nelson's fine imagination and execution.

In addition to the descriptive placard, referred to by Mr. A. Nonemous, he has arranged for another one which informs newcomers of Rogers' location at Copley Square. More and more artifacts are being gratefully received. Many constitute things that in time, were it not for a collection such as this, would be thrown away, to everyone's loss. Now there is a place for this memorabilia. Recently Director Seamans was glad to receive valuable material from Christine Beadle relating to her father, Professor Charles Spofford. Some people have donated trophies. Anyone having anything of historical value will be assured of a good home for it. The atmosphere of the Collection, although it is in a warehouse-type building, is warm and enticing. Be sure to see it at your first opportunity.

Clarence Seely had to miss Northfield again in spite of the following, "I am looking forward to being at Northfield. It's my event of the year for I am still in harness and never get far away from my work. People think I am crazy to keep working. So I commute 50 miles by train in the morning and back at night. This totals four hours travel time for eight hours work. My work is interesting. I'm doing just what I trained for at M.I.T., engineering." Clarence is with Gibbs & Hill, Inc., N.Y.C.

The word from **Alex Kenigsberg** of their trip in May is of particular interest in these troublesome days. "The visit to Teheran seems to rate some reporting. A modernizing city of 4 million and, on three sides, surrounded by the snow-capped Alborz mountain range. Teheran is an awakening commercial, industrial and economic giant, the center of national advancement under the energetic guidance of an ambitious and autocratic shah. Of interest to tourists are the royal palace, imposing and beautiful, now unused mosques with intricate mosaics, some modern stores, beautifully developed boulevards, the multitudes of people on the streets, bewildering traffic of mostly European cars, women wrapped in traditional 'chadors' over the latest style dresses and ultra high platform shoes. Overwhelming is the only word to be used for the fabled royal jewels. Their wealth, richness in kinds and unexcelled beauty can be perceived only by the living eye alone."

Penn Brooks appeared briefly in the Cambridge-Boston area in late October, attending a convocation of the Sloan School he once headed. His cattle-raising business, at his Buxton estate in Virginia, suffers currently from the drop in the price of meat. He has killed and buried no calves but will carry them through another year not for a significant gain but hopefully with smaller loss. . . . It was good to have a phone call from Chi Kuan Wu the lad who came here several years ago, the grandson of **Poh Y. Hu**. Last fall Chi Kuan got his Masters in Mechanical engineering, specializing in nuclear power. He has not found success yet in job hunting but thought that he was about to land one.

Our sympathy goes to **Connie Coakley** on the loss of his wife of 56 years.

"Time on *The Tech* during sophomore through senior years was a rewarding experience for me. Lobby's blue pencil was effective and was educational in itself; so was 'putting the paper to bed' in downtown Boston, at 3 A.M., rather rugged." So writes **Ray Brooks**. . . . Best wishes are acknowledged from **Charles Gager** who has entered The Westgage Convalescent Center at San Jose, Calif. . . . It is always pleasant to receive word from the classmates, even brief ones. So when 99 take time to return the Reunion cards out of a total of 179 active, some with messages some without, it is gratifying. As space won't permit more than acknowledgement it is good to list the names; **Sampson**, **Lewis**, **Coakley**, **Peacock**, **Ray Brooks**, **Medding**, **Tapley**, **Melvin**, **Gokey**, **Blandchard**, **Wilson**, **Solakian**, **Lyons**, **Swain**, **Creighton**, **Ham Wood**, **Woodward**, **Burkhart**, **Goodale**, **Kenigsberg**, **Ferretti**, **Curtin**, and **Flaherty**. There will be more next time.

The word of the death of **Dudley E. Bell**, on November 26, was received just at press time.—**Stanley C. Dunning**, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard**, Assistant Secretary, 21 East 87 St., New York, N.Y. 10028

18

There is something about this season of the year (Thanksgiving) that results in a dearth of news for these class notes—for this is a repeat of last year's experience. I hope you all take heed and respond quickly with tales of what you are doing and thinking—or else you will suffer with whatever ramblings go through my mind. All of which concerns the fact that I recently was chairman of the 1974 M.I.T. Alumni Officers' Conference in early September which brought some 767 of us (a record) together at the Cambridge campus from all over the United States and a few from foreign countries. There were stimulating talks by M.I.T. leaders in their fields—a

most interesting mini-seminar on M.I.T.'s involvement in food, population and politics—and the first report of a survey of M.I.T. alumni. The latter was the subject of much discussion which yielded more questions than answers. I list a few herewith: 1) What is the real purpose of the M.I.T. Alumni Association? Is it social—for reunions and the like? Is it fund raising? Are there other goals—policy making with M.I.T. administration—continuing education—involvement in societal problems? 2) Is there a gap between the younger and older alumni due to their different interests and philosophy? 3) Are smaller M.I.T. clubs being neglected in favor of the larger ones—in part due to more attention to the latter by M.I.T. itself? 4) How can communication between Cambridge and you be improved—particularly so that those of you furthest from the campus can become more involved. 5) What about continuing education—what do we of the older classes want M.I.T. to do in this area? I would like to have your comments on these vital issues.

Len Levine is responsible for these responses to letters from him to several of you. **Eaton Clogher** writes: "Certainly was surprised to receive your note. If as you say, it has been four years since you wrote, my comment—where the hell did the time go? My wife's health is such that I am kept very tied down. She cannot travel any length of time. She can walk with the aid of a cane and a companion short distances. She has no energy; doctors say she never will have. For a person of her former activities this present state of her health is quite a come down. Thanks be to God I am in good shape, no complaints, kept very busy and have every reason to feel that I am fortunate. Things could be much worse. Isn't it about time you quit? No need to push yourself into an early grave. Relax, you have done your share.

Recent class news listed a chap named Swan as now a resident of Madison. I do not know him. If I get a chance I'll look him up. . . . The election is over. I am pleased with the over-all results. I never could see this S.O.B. Nixon. You may recall my youngest sister Molly. She is blessed with a very keen political insight. She also abhors Nixon and when he was elected she told all her circle of friends in Miami Beach he would never finish his term and that he would be out in disgrace by April, 1974. She only missed by a few months. Well, Lenny, let us hope we can exchange notes in another four years. Again many thanks for your note."

Bob Gidley responds: "I was about to mail you the enclosed photocopy when your letter came in. Enjoyed hearing about the reunion and how you are getting along. I miss not seeing more news of classmates in the *Review* but that is to be expected, I guess. I will be 82 in January and stay pretty close to Dallas. My doc reports that I am in good condition, adding "for a man of your age" I still drive and do some of my own yard work but in general take it easy and try not to overdo. As a hobby I took up oil painting. That gave me a lot of pleasure and the results were not too bad. The biggest thrill of 1974 was the arrival of our third great grandchild. We now have two great granddaughters and one great grandson. And that's about all there is to report.

Hope the enclosed photocopy will bring back interesting and pleasant memories. In looking through some old souvenirs I found the original of this drawing I made nearly 60

Samuel and Narcissa Chamberlain's 800 Cook Books as a Resource in Social History

Almost everybody knows Samuel V. Chamberlain, '18, as an etcher and photographer of the classic, even nostalgic, New England scene. Fewer know him and Narcissa, his wife, as gourmets—the authors of sumptuous and elegantly illustrated cookbooks recording the delights of British, Italian, and French cooking. Fewer still know them as collectors of cook books—over 800, as it turns out, including some important classics dating from the 18th century.

The collection has now been given to Radcliffe's Schlesinger Library on the History of Women in America, where it joins the papers of Julia Child, who is best known through her television series, "The French Chef," and M. F. K. Fisher, author of *How to Cook a Wolf* and *Consider the Oyster.*

The Chamberlain collection includes such classics as Massialot's *Le Nouveau Cuisinier Royal et Bourgeois* (Paris, 1734); a number of titles by M. A. Careme, including *Le Maitre d'Hotel Francais* (Paris, 1822) with menus and elaborate place settings for every day of the year and every occasion of importance; and the rare English volume, *The Pantropheon, or History of Food Preparation* by A. Soyer (1853). Other titles: *Chinese Gastronomy—How to Cook a Rogue Elephant,* and a 1721 edition of *Le Vrai Cuisinier Francais,* first published in 1651.

Mr. and Mrs. Chamberlain were drawn to old cook books simply because they were curious about their contents; they experimented with recipes in the intriguing books they collected from stalls along the banks of the Seine in Paris during the 1920s while living in a small French village (Mr. Chamberlain had served during World War I as an ambulance driver in the French Army). Finally the Chamberlains acquired a copy of the classic bibliography of works on gastronomy by Vicaire; then they knew they were hooked, that some of the books on their kitchen shelves were rare, even valuable.

Now the collection includes almost every writer of consequence in the field of French cuisine in the 18th and 19th centuries, and Harvard University says the Chamberlain gift "establishes the Schlesinger Library's collection in the gastronomic and cooking field as one of the most important in this country."

Why collect cook books? The answer is obvious enough if you're a gourmet with an experimental turn of mind, like Mr. and Mrs. Chamberlain. But it you're a library on the history of women?

Because, says Patricia King, Director of the Schlesinger Library, cook books are "a very good source of information on social history. There's a whole life style reflected in book books"—domestic life, etiquette, aesthetics. "An untapped resource for the history of domestic and social customs, and particularly for the role of women within the family and the larger community," says Mrs. King.

Samuel V. Chamberlain ('18), and Mrs. Chamberlain, have given their collection of 800 cook books to the Schlesinger Library on the History of Women in America at Radcliffe College, where the books become the center of one of the most important collections on gastronomy and cooking in the U.S. This picture of Mr. Chamberlain with famed Boston cook Julia Child was made at a fall reception at which the Schlesinger Library honored its new donors and displayed the highlights of the collection. (Photo: E. Barbara Boatner)

years ago when we were taking the intensive course in naval architecture. So I had copies made for several friends who took that course with me. Glad to know you are still active in your work of teaching schools."

Frank Burke wrote to Len that he is enjoying retirement—is doing much reading—and enjoying it.

It is with great sadness I report the passing of **Tom Brosnahan** on October 29, 1974. Tom was one of our most active and loyal classmates—came to Cambridge for nearly every '18 function—made frequent contributions to these columns—and added the pleasure of all our get togethers. We shall miss him. Our deepest sympathy goes to his wife—who participated with him on these many reunions.—**Max Seltzer**, Secretary, 60 Longwood Avenue, Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 519 Washington Street, Brookline, Mass. 02146

19

The New York Times November 5 carried the story of the death of our classmate, **Harry Al Kuljian** on Saturday, November 2 in the Philadelphia area. He lived in Bladwyne, Penn. In 1950 he invented a rayon spinning machine. He worked for Stone and Webster, Westinghouse and American Viscose Corporation before starting his own Kuljian Corporation, an industrial construction company, in 1930. His company built power plants, industrial sites and transportation systems. In Philadelphia he developed the design for the International airport and built the Broad Street subway extension.

Correspondence from the Alumni Association gives a new address: **Paul D. Sheeline**, Moors & Cabot, 111 Devonshire St., Boston, Mass. 02109. . . . A note from **Edward Adams Richardson** states, "Emphysema greatly limits activities. Not much to report. Great credit to my wife for keeping me going." . . . **Nelson A. Bond** wrote from Schenectady, N.Y., where he spent the summer, that he will be returning to Florida in the middle of November.

Alexis R. Wiren writes from Majorca, Spain, where he was vacationing for a month from his duties as Special Assistant to the President of Dowling College, Oakdale, Long Island, N.Y. . . . Your President **Donald D. Way** has written to me several times during the past month. Both he and I thought the 55th Reunion in June was a "bang up affair and he sent some snap shots taken at Chatham Bars Inn. Don mentions the tribute to **"Dusty" Rhodes** in Yachting Magazine. We are expecting to see Barbara and Don in Delray Beach at their annual visit here this winter. . . . Your secretary will spend Thanksgiving in Jackson, Miss. visiting our daughter who has just moved there. We will also visit New Orleans.—**E. R. Smoley**, Secretary, 50 East Rd., Delray Beach, Fla.

20

A word of explanation and apology for the more or less frequent misspelling of classmates proper names in these notes. It is not the fault of Marjorie Lyon, the long suffering editor of class news. Rather, it is the fault of this writer whose longhand writing leaves something to be desired. (I never did learn to typewrite having been blessed with an efficient office secretary for many years.) Henceforth I shall try to remember to print the names as painstakingly as possible.

It is always heartwarming to hear from you readers and I am expecting a flurry of mail from now on due to our impending 55th. Keep 'em coming fellers even if you haven't yet made up your mind to attend. It does wonders for our morale. **Bob Bradley** who summers at South Dartmouth, Mass., and winters on the Florida east coast, indicates that he is alive and kicking. More power to him and Ruth. . . . **Fred Earle**, Capt. U.S.N. (retired) is a resident of Carl Vinson Hall, McLeon, Va., set up for commissioned officers of "sea services".

I am sure the class joins me in expressing condolences to **Gerry Tattersfield** upon the loss of his wife, Doris, just a few weeks before their golden wedding anniversary. Gerry's address is 8035 Seminole Ave., Philadelphia. Another relatively recent widower is **George Wilson** who is carrying on with his hobbies—mineral collecting, his Cape Cod summer cottage, and his activities with the local Kiwanis Club. George, whose winter address is 38 Worthington Circle, Braintree, Mass., would be interested to hear from other mineral collectors in the class.

One of our most widely known and admired classmates, **Harmon B. Deal**, died early last year. Harmon lived at 4801 N. Audobon Road, Indianapolis. I must also regretfully report the death of **Ellsworth V. Holden** of Amstel House, Newcastle, Dela.—**Harold Bugbee**, Secretary, 21 Everell Road, Winchester, Mass. 01890

21

Happy New Year! May 1975 treat you kindly. . . . A letter from Graciela and **Heller Rodriguez** early in November told of a wonderful tour of Mexico which they took during October with their friends, the Bernardo Elosuas, '23, of Monterrey. They covered a lot of territory and while in Mexico City visited **Viviano Valdes**. We were sorry to learn that Viviano had recently undergone surgery but Helier reported he was doing well. The Rodriguezes became American citizens this year. Hopefully, we will be seeing them this winter at another mini-reunion in Florida. . . . **George Gokey** of Charleston Heights, S.C. writes that he and Eddie have now become acclimated to hot summer temperatures after living so many years in Jamestown, N.Y. Fortunately they love hot weather and took refuge occasionally in the outdoor pool— "bath-water hot but wet". They saw the **Ben Fishers** in St. Maarten last winter and plan to return there for six weeks this winter.

Alumni Fund envelopes have provided the following gleanings: **C. Levon Eksergian** of Stillwater, Penn. writes that "like the bachelor who was asked quite innocently about his children: How many? replied 'none to mention'. This holds for me." We understand that Stillwaters run deep. . . . **Horace Tuttle** of Bloomfield, Conn. reports that "we enjoy activities of our Senior Citizens group two days a week. We're learning square dancing and take trips by bus every month. We recently took a foliage trip to Cathedral of Pines in New Hampshire." . . . **Albert Genaske** made a second visit to Helen St. Laurent's summer home on Vinalhaven Island in Maine (no fog this time?) and expressed the hope that Helen would visit them on her way back to Connecticut. . . . **Asher Cohen** of Baltimore, Md. took a fall trip to Denver, Colo. to attend a national S.C.O.R.E. conference as a delegate representing the state of Maryland. Asher continues to be active as a consultant and advisor in this field. . . . Cecilia and **Arnold Davis** of Berkeley Heights, N.J. headed north this summer and toured around Maine and Nova Scotia. They were unsuccessful in finding postcards with pictures of libraries thereon (Betty Hayward is a collector of these) but "many thanks for looking".

Sadly we record the deaths of three more classmates: **Abraham M. Aronson** of Jersey City, N.J., **James F. Curtin** of Freeport, Ohio and **Henry N. Hallett** of Canton, Penn. Aronson prepared at City College of New York, entered M.I.T. in his junior year, and earned an S.B. degree in Course XIV. In his business career he became Chief Engineer of the Northern Air Conditioning Corp. in Newark, N.J. Henry Hallett also entered in his junior year after preparing at Cornell University and got S.B. degree in Course II. Henry was the owner of Hallett Motor Co. in Canton, Penn. He and his wife were amongst those who attended our 50th Reunion. The sympathy of the class goes out to the families of these classmates.

Early in November our Class Photo-Historian **Bob Miller** headed back to Maryland from the Millers' cottage on Cape Cod. Bob reported that he and Helen hosted a dinner shortly before departing, at which Marion and **George Chutter** and Hazel and **Whitney Wetherell** were guests. The Millers stopped briefly in Westerly, R.I. to visit with Emma and **Al Lloyd**. The Lloyds had recently travelled by bus (thereby saving gasoline) to visit their son and family in Virginia and their daughter and family in Atlanta, Georgia. The Millers got together for lunch in northern New Jersey with **Joe Wenick** and the **Haywards**. As expected some photos were taken to record the event. Joe and Dorothy Wenick's son Martin, after a concentrated study in Washington, to learn the Italian language, has now been assigned to the American embassy in Rome as first attache. Martin now speaks nine languages.—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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Your Secretary and roommate spent part of early November in San Francisco and surroundings with much pleasure. We enjoyed the Fairmont Hotel with its beautiful banquet rooms, restaurants, and Crown Room. Our meetings in the new Hilton were very constructively arranged and the Convention Center was perfect for our National Electrical Contractors group. The weather cooperated, allowing us to enjoy the Pacific Coast, San Jose, Carmel and the Cable Cars. Really this is the wonder-spot of the world. Of course, we still had golf weather in Buffalo. . . . **Parke Appel**'s news letter regarding the 55th Reunion asks for an answer and your vote. He also reminds us of the Profes-

sorship and Career Development Fund. Thank you, Parke, for including our request for more Class News to be forwarded to Buffalo. . . . **William H. Mueser** has been selected to receive the "Outstanding Achievement in Construction" award by The Moles, an association of men engaged in heavy construction. He will receive a bronze plaque and hand engraved illuminated citation at the Award Dinner on January 29, 1975 at the New York Hilton. Bill is senior partner of the consulting engineering firm of Mueser, Rutledge, Wentworth & Johnston. Bill's interest in M.I.T. has been continuous in many fields and on numerous committees. He received the "Engineer of the Year Award" in 1958 from the American Society of Civil Engineers. He is a registered civil engineer in 17 states. His firm's work includes designs of deep foundations for the important buildings of lower Manhattan along Wall Street, Broad Street and Battery Park City. He did the underpinning of the Sub-Treasury Building on Wall and Nassau Streets. His dry dock designs included the Navy's Puget Sound Dry Dock #6, Bremerton, Washington, the world's deepest and largest with a length of 1,152 ft. His work also included the special caissons for the San Francisco Bay Bridge and the Huey P. Long Bridge in New Orleans. Bill has been a great member of our class and outstandingly loyal to M.I.T. . . . **Elmer E. Sanborn** has still the record of October 13, 1973 for 2 miles in 15 minutes 45.4 seconds at age 73 and 3,000 meters (14 minutes 42.4 seconds) as listed in the World Age Records. . . . We were glad to hear from **George C. Maling** of Brunswick, Maine. . . . **Vernon E. Whitman** of Rochester, New York has written of his continual contacts with three classmates since 1922. They were **A. L. M. Dingee** who originally insisted on setting up tutoring services in the shadow of the dome. Also **Bill Elmer** "whose post-1967 feud with Johnson et. al. seems to have known no bounds".

Vern's letter was written because of the recent passing of **Louis P. Tabor** at Bryn Mawr Hospital in October. Louis taught physics and chemistry at the Episcopal Academy of Overbrook, Penn. until World War II when he returned to M.I.T. to work at the radiation laboratories. He then joined the Navy and became the chief of guided missiles and continued to participate in the Naval Training Program, being selected for promotion to Captain. Later he joined R.C.A. at Moorestown, New Jersey and later was employed by Spitz Space Systems. Our sympathy goes to his wife and family. Vernon Whitman and Irene are looking forward to renewing friendships at the 55th Reunion. . . . **Florence W. Stiles** has had a successful cataract operation but is somewhat restricted in exercise. She is now compiling records for the coeds for M.I.T.'s Historical Museum Collections. . . . We were also happy to hear from **Irving Whitehouse** of Cleveland regarding an Arthur D. Little report. . . . **Mildred Allen**, a professor at Mt. Holyoke College, has recently given a paper with Erwin J. Saxl on "A Precision Torsion Pendulum, Recent Improvements and Results" at the Clark University meeting of the New England Section of the American Physical Society. . . . **Albert L. Sargent** has sent a beautiful picture postcard from Naples of the race-course at Agnano. He and Fran are cruising the Mediterranean and will go to Capri, Corfu and Malaga before returning to Southampton and Melrose. . . . **William W. K. Freeman** of Salem, our retired-to-teaching classmate, has written for help in finding an outdoor, bracket type, alcohol thermometer graduated in only Celsius (formerly Centigrade) degrees, to be read through a window. Help will be appreciated. Bill also enclosed complimentary clippings of Buffalo schools and an article he wrote in the Salem Gazette on metrics. Your secretary hasn't gone beyond $E=MC^2$.

The sympathy of our class is extended to the families of **Adrian J. Gilardi**, Seattle, Wash., **Tom T. Freeman**, Denver, Colo. and **Fullerton D. Webster** of Mountain Lakes, N.J. We also extend our sympathy to the family of **Bennett Levenson**, a retired patent attorney of Washington, D.C. Mr. Levenson worked for the U.S. Patent Office before establishing his own patent practice. He was a member of many organizations and clubs and is survived by his wife Charlotte of Rockville, N.H. . . . We hope that most of your '22ers are reading these notes from warm and sunny spots while preparing for a Bigger and Better 1975—Happy new year! . . . **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

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Uncas A. Whitaker was selected to receive the Distinguished Achievement Award of the Alumni Association of Carnegie-Mellon University. Uncas is chairman of the board of A.M.P., Inc., of Harrisburg, Penn. He was awarded this recognition for his distinguished professional accomplishments at homecoming ceremonies of that university on October 25 last. After taking his degree with our class he obtained his electrical engineering degree from Carnegie-Mellon in 1929 and a degree of J.D. from the Cleveland Law School. His professional career includes employment as special engineer with the Westinghouse Air Brake Co., director of development and design with the Hoover Co., of Ohio and director of engineering and research with the American Machine and Foundry Co., of New York City. In 1941 he founded Aircraft-Marine Products, Inc., the predecessor of A.M.P., Inc. Whitaker is a Life Member of the Corporation of M.I.T. and the American Association for the Advancement of Science. Also Uncas is a Fellow and Life Member of the American Institute of Electrical and Electronic Engineers, a Distinguished Fellow of the Cleveland Clinic Foundation and a member of the Newcomen Society of North America. Other honors include the 1970 Eli Whitney Memorial Award of the American Society of Mechanical Engineers as well as a fellowship of that organization. Topping everything, of course, is his generous gift of the Whitaker Building, a tour of which was a high point of our 50th Reunion.

Norman L. Weiss of Tucson, Arizona was elected an Honorary Member of the American Institute of Mining, Metallurgical, and Petroleum Engineers on October 30, 1974. He will be an honored guest at the annual banquet of the Institute and will receive the Ceremonial Medallion and Certificate in New York on February 19. His citation reads, "In recognition of his contribution to the art of ore processing through half a century of process development, mill administration and operation, and achievements in plant design; his service to the Institute and the Society of Mining Engineers in a number of capacities including editorial responsibilities in connection with the Mining Engineering Handbook and the Mineral Processing Handbook; and, finally for his interest in the education and professional development of the younger engineers."

We have just learned of the death of **Ralph R. Dresel** of San Francisco on July 5, 1974. We also have access to a letter of appreciation, written by his widow in August, to Dave Davenport concerning Ralph's enjoyment of the class history read to him by Mrs. Dresel due to his recent blindness. She ends her letter—"The family is more than pleased to have such a record of this outstanding class of which he was a member." After graduation Ralph was an assistant in the Civil Engineering Department, at M.I.T. Later he entered the insurace industry as a safety engineer and later became an Insurance Broker.

Sent to us by **John C. O'Flaherty** are newspaper clippings concerning the death of **Clarence A. Braukman** of Denver, Colorado on October 30, 1974. Clarence was born in 1897 in Cleveland, Ohio and settled in Colorado in 1905. After graduating from public schools in Denver he attended the University of Colorado and during World War I became a Captain, Aviation Section, Signal Corps, U.S. Army. In 1922 he served on the faculty and staff of the Aeronautical Engineering Department at M.I.T. His career included flying the air mail between Denver and Cheyenne and later was rated as U.S. Air Mail Pilot 45 on the Denver-Cheyenne-Omaha-Salt Lake City runs. Other employment included service with the U.S. Department of Commerce concerned with pilot licensing and air safety. After other industrial positions he became President of Screw Machine Products Co. of Denver, retiring in 1970. In 1973 Clarence was inducted into Colorado's Aviation Hall of Fame. Quoting John O'Flaherty—"Braukman was one of the best".—**Thomas E. Rounds**, Secretary-Treasurer, 990 A Heritage Village, Southbury, Conn. 06488

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A timely way to begin the new year is to record the background of our distinguished classmate, **Luis Ferre**, current president of the M.I.T. Alumni Association. None of the information came from Luis himself, so if we have erred, our apologies are in order and we stand corrected. It seems that in 1879, Ferdinand de Lesseps, promoter of the Suez Canal, became head of mainly a French syndicate to build the Panama Canal. Before the project failed in 1889, Luis' French father was recruited as an engineer there, but was fortunate enough to escape the deadly epidemic and move to Cuba. At the age of 19, during a Cuban revolution, he entered Puerto Rico. Having no formal education, he studied and worked hard to become a capable engineer. It is thought that he married a Cuban girl, but in any event, he decided that the best legacy to leave his children was a good education.

Luis and Carlos, two of his six children, went to M.I.T. Carlos was in the Class of 1928, but has passed away. Luis and **Al Roig** met on the boat coming to the United States and decided to be roommates. The inevitable followed when Luis' sister, Saro, be-

came Al's wife. Of course they are exceedingly proud of their six grandchildren, who adore the former Governor of Puerto Rico. Reduction of Luis' governmental duties has meant a "plus" for the Institute in expanding its young Council for the Arts program. He is an accomplished pianist and founder of an Art Museum in Puerto Rico. He attended the Third Annual meeting in November, titled "Evening with the Arts at M.I.T." The day and a half meeting included business sessions, musical offerings, art facility visits and seminars with faculty members in the arts.

Eleanore and **Bill MacCallum** were back in the South Pacific in October after six years and write from Wellington, New Zealand. They stopped in Honolulu and way stations and made the rounds—Christ Church, Mt. Cook, Dunedin, Tasmania and Melbourne. Although their card pictures Memorial Olympic Swimming Pool, I doubt that this implies that their propulsion was via the Australian crawl.

This reminds me of "The Tech's" August article on "Sports at M.I.T." It begins, "M.I.T. is the biggest jock school in the country." The fact is that the Institute has more intercollegiate sports than any other N.C.A.A. college. Students actually participate in practically any sport that comes to mind, even being national champions in frisbee (aerodynamics training) and tiddly-winks (elastomer properties of materials). Pistol and fencing teams and crews have been national champions and individual stars have been champions in track, wrestling and tennis. Sports are not a big business and no recruiting is allowed. No participant is "cut" from a team squad and this requires a special breed of coach. Statistically, our participants tend to do better academically than their less active brethren, but it is a little unusual to see a bearded individual, hair ribbon flying, running a quarter mile around the track.

The "I.E.E. Spectrum" of September 1974 carries an article on Facsimiles or "Fax" in the home. The earliest fax broadcast venture was that of **Austin Cooley** in 1926. He persuaded more than two dozen broadcasters to experiment with a system he called "ray photo." It worked, using corona discharge, but was temporarily abandoned because of low speed and noise. R.C.A. and General Electric got into the act, but later, Austin founded Times Telephoto Equipment, renamed Times Facsimile.

Curly Fletcher notes on his Alumni Fund envelope from Vero Beach, Fla., "Our big event of the year was going to the 50th Reunion, and you know about that." . . . All this month's news emanates from Florida. Frank Fricker, '25, kindly sends me a "Naples (Fla.) Daily News" clipping of October 30 with an excellent picture of Lorene and **Paul Cardinal**. The article states that Paul has found tranquility in Naples after a career in marketing pharmaceuticals for Hoffmann-LaRoche, Nutley, N.J. by collecting shells, playing tennis, swimming and aiding the green thumb of Lorene. At the Institute, apparently, Paul had journalism in mind, and as editor of "The Tech" had an opportunity for humorous writing, but national attention was attracted by an article on the serious side of Prohibition.

Upon graduation, he had second thoughts and decided to try advertising. In a New York interview he was told of a small Swiss drug company which wanted an advertising manager for its U.S. operation. He studied medicine and health care references and in three months was running ads in medical and dental journals. In 1930, Hoffmann-LaRoche acquired patents on vitamins, notably A, C, B-1 and B-2. Paul decided to expand vitamin use by processors of flour, milk, beer and food products. World War II revealed the importance of vitamins and his contributions were recognized by advancement to vice president. He retired early at 59 in 1963, but lust for activity led to consultant for the Institute of Human Nutrition at Columbia University for a few years and then as a volunteer recruiter for the International Executive Corps. Along with all of this, Paul has always been a serious and devoted worker for the class and M.I.T.

Clint Conway asks me to remind all members that the Third Florida Fiesta will be held in the Tampa-Clearwater area Friday and Saturday February 28 and March 1, '75. Dinner on Friday will be in the Green Heron Restaurant of the New Bay Harbor Inn on Route 60, one traffic light from I-75. On Saturday, cocktails and lunch will be available at the Conways, 805 Maximo Ave., Clearwater, Fla. 33519 (Phone 813-726-3625). The popular informal arrangements will be in order.

I'm sorry to report the death of **Boyd E. Oliver** on October 1, 1974 in Ocean Park, Wash. Boyd came to the Institute from the University of California and received his S.B. degree in civil engineering. In 1967, he was president of Dry Mix Materials Company, Roseville, Calif. He was a member of Kappa Alpha fraternity, but we have no further information on his career.—**Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, Co-Secretary, 8 Pilgrim Road, Waban, Mass. 02168

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When I wrote the date for these notes I realized that this was the beginning of our big year toward which we have all been looking. I am not quite sure of my meteorology terms and "Weather" I should issue a Reunion Watch or just a Warning, but of one thing I am sure; it is fast approaching. I hope that many of you will make it and be able to see the many changes that have taken place at M.I.T. Having lived in Cambridge most of the years since graduation, I have lived with most of these. For those of you who have not been back, be prepared for a pleasant surprise.

I received a letter from M. Kametani (Kami) and wish I could reproduce the detailed schedule of a trip that he was making to the east coast. Starting from Toyko and returning there, it listed all of the places he would visit and some of the friends with whom he would be stopping. My apologies to Kami, but I was not able to connect with his visit to M.I.T. . . . I had another interesting letter from **Geoff Roberts** with reunion questions. He reports that they expect an early winter in England and I judge that he is not enthusiastic about the Labor Government. They certainly are having their economic problems and such things are not limited to the U.S.A. . . . **Jonathan Holman** writes from San Antonio that he hopes to visit M.I.T. in the spring or summer. I should think that reunion time would be ideal. . . . **Berard Smith** of Gloucester, Mass. said that he had little of interest to tell classmates, but I note that he retired some time ago because of ill health. . . . **Roger Ward** has just returned from a freighter trip around the Mediterranean. This winter he plans some free lance writing plus making some orange wine. Then he plans to be off for Australia and the Straits Settlements. He will make the reunion if possible. . . . **James C. Evans** of Washington, D.C. calls our attention to the fact that his son, an M.I.T. graduate, has "extended" with three grandsons thus giving him three chances to make M.I.T. into the third generation. He also noted that he was writing on the same Remington Portable that he bought at the COOP in 1924. . . . **Bill Herbert** says that 1974 has been a good year for a semi-retired professional engineer. He is most active as a "Busy-Body" in the Petroleum Engineering Society, Junior Engineer Technical Society, Huston Chamber of Commerce, Chairman of local T.S.P.E. mass transportation study committee, the Gideons and of course his family.

I am sorry to have to report the passing of **Harry P. Henderson** of Woodbury, Conn. on March 16, 1973, of **Gilbert H. Sechrist** of Lincoln, Neb. On Sept. 14, 1974 and of **Charles M. Smith Jr.** of Montgomery, Alabama on Aug. 14, 1974. Thanks to an assist from **John E. Black** of Bristol, Tenn. I am able to give a little more detail about Charlie. After teaching at M.I.T. for a short period following his graduation he returned to Montgomery and joined his father's laundry business. He was a member of a number of civic organizations in his home town and served as a member of the board of the First United Methodist Church. He was on the Board of Directors of the American Institute of Laundering. He is survived by his widow, two sons and a brother.—**E. Willard Gardiner (Will)**, Secretary, 53 Foster Street, Cambridge, Mass. 02138

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This mid-November weekend finds things at Pigeon Cove nearly battened down for the winter blasts. Burlap screens protect the laurel and the inkberry bushes, the rugosa roses have been cut back and the Bullseye rests on its trailer in stall three of the garage. We have acquired a Reddy heater that will allow working on the boat whenever the spirit moves. Before the ground freezes we have 60 driveway markers to install to guide the plow and with the morning temperature at 30° it looks like a today assignment. A few weeks ago Ruth and I decided to head north for a couple of days and got as far as Boothbay Harbor which is a delightful spot—crowded in summer but not in mid-October. We called **Win Russell** at East Boothbay and arranged to see him for a half hour before church, and he brought us up to date on his activities. Since I always find it fascinating to learn what another classmate does in retirement he wrote following our visit and an excerpt from Win's letter follows: "You mentioned that you haven't heard much from me lately; well I'll tell you the reason—I'm retired. Since retirement I've been busier than ever before, in fact I tell people I'm looking for a job so I can get my feet under a desk and give them a rest. Among the dubious titles that have been conferred upon me: President, Murray Hill Assoc. (where we live); Vice President, Faruham's Point

Assoc. (where our cabin is located); member town conservation commission (we're not against everything); trustee and Chairman of Finance of the local church. Also I am "back up" for the superintendent of the Water District (I operate the system when he goes on vacation—reporting to the District Commission). Also **Dick Sherman** and I are on call to advise the town manager on technical matters within our several fields. Most of all we have the "Lamp Shed" a shop which keeps us more than busy for three summer months. Other retired M.I.T. men in the area are Willard Van Allen, '24, who lives nearby, and John Vaupel, '22, who lives on Barters Island. **Philip Richardson** retired to Spruce Point but I never managed to contact him. He passed away a few months after I moved to Boothbay. Mrs. Richardson is active in our Coastal Club (Senior Citizens). I should mention I'm an active member of Volunteer Fire Co. #1. Best regards, Win Russell." . . . If our roots were not so deep in Pigeon Cove, the Boothbay region would be most tempting. There is a new condominium in Boothbay Harbor smack on the water and adjoining the Yacht Club. For some reason in spite of its location it hasn't filled up—we suspect price may be the reason.

We talk with **Austin Kelly** frequently—he spends two days a week at his New York office and we were at the Alumni Officers Conference recently when he was presented a Bronze Beaver—M.I.T. Alumni Association's highest award. Austin's grandson, Austin W. Crowin became a freshman at M.I.T. this fall and we hear that he is promising material for the sailing team. . . . A recent letter from Cairo proves that **Whitney Ashbridge** is still the world traveller and big game hunter. "Dear George: Since I retired four years ago, we've travelled a good deal—several times back and forth across the continent (North America) from Prince Edward Island to British Columbia and southern California to Florida. Then we were on the west coast of South America on one trip, Rio de Janeiro on another. A trip to Scandinavia, including the 11 day mail boat trip around the North Cape to the Russian border. Another trip through southern Europe as far as Istanbul and half a day in Asia Minor. A Safari in Rhodesia, as I have always enjoyed hunting. Last fall and early winter we were in Taiwan, Hong Kong and Japan. Now we're seeing Egypt, and soon heading to South Africa for a trip on the Indian Ocean side, Kruger National Park, and then across to southwest Africa, where I go on a ten day hunt out of Windhoek. We've seen and enjoyed a lot of things which we'd never had time to get to before." Wow! Is that last statement an understatement and all this from a guy who had a stroke a few years ago. But it's time to go and install the driveway markers so until next month—Cheerio—**George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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The mail has been very slim this month. Unhappily, I have two very belated obituary notices to report.

Archie C. Higgins died on November 18, 1970, at Hopkinville, Kentucky. He had been president of Higgins Bros., Inc., in Hopkinton, an had served during the war as a first lieutenant in the U.S. Army.

Edwin H. Himrod died on October 3, 1971; he had also served in the army in World War II, as a captain. The obituary notice lists an address in Rockville Center, N.Y., but Ed had lived for many years in the Miami, Fla., area, where he operated his own home construction company.

For any of you who may have missed **Ray Hibbert**'s recent reminder, I should call your attention to the fact that, as you read this, our 50th Reunion is less than 2½ years away, and we shall have to step up our contributions in these next 2½ years if we are to make an anniversary gift we can be proud of. Any gifts to M.I.T. between July, 1972, and June, 1977—that is, in effect, between our 45th and 50th Reunions—count toward the anniversary gift. . . . As these notes are written, just before Thanksgiving, I am still trying to catch up after the trip Marion and I took to Britain and the Low Countries in September-October. Thinking back on the trip, it seems to me the highlight was our visit to Stonehenge. If you have never seen it, and find yourself anywhere in England, it's well worth the trip. I am still amazed at the complex mathematical equations the old Britons were able to work out, not only without computers, but even without Arabic numerals.—**Joseph H. Melhado**, Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

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First, our hearty wishes to all of you for a happy year ahead with good health and good luck in all of your endeavors! . . . In his letter to the class last fall **Jim Donovan** invited any of you to call him collect by telephone any evening at his home. This was a great idea except that the number as given was wrong. Now he has asked that we pass along the correct number which is: 617-547-9751. The invitation still stands, of course. If Jim happens to be out you can talk with Frannie. . . . In a recent telephone talk with **Al Gracia**, Jim was pleased to learn that Al and his wife Jo were planning to make a very generous gift to the 50th Fund. The Gracias spend three months each summer in Maine and three months during the winter in the Virgin Islands. Now they are planning to move to Connecticut where they can be at an intermediate point and also near their daughters. Possibly they will settle near **Mary Nichols** in Farmington and so establish a '28 nucleus in that area.

Two of our most faithful correspondents, Mary and **Max Parshall** wrote to Jim and Frannie about their late fall activities. This included two trips down the Salmon River in October. Max caught a steelhead trout each time. One weighed eight pounds and the other weighed fifteen. Max is also well acquainted with moose, an animal he doesn't care to meet when he is fishing (Max, that is). . . . A brief note from **Jim Rae** says: "I've been retired for two years now and have lived in Sea Girt, N.J. for one. It is peaceful here and especially enjoyable when the children and grandchildren all come to enjoy the ocean." . . . **Ethel Yood** wrote to say that she retired from the Brookline (Mass.) Public Schools in June 1969. Since then she has been supervising student teachers at Boston University and at Brandeis. . . . **John Ryan** has used some of his retirement time preparing a special map for his town of Winchester, Mass. showing the location of open land and the distribution of older citizens. The study showed that the oldtimers in that town are well distributed rather than being clustered.

When the Wellesley Class of 1929 held its 45th Year Reunion last June **Florence (Jope) Smith** was elected class president for the ensuing five year period. (It's just an old family custom.) And while we are discussing family matters—Florence and her new husband managed to get in a second honeymoon trip at the end of October. This time it was to Niagara Falls, N.Y. where your secretary had a speaking engagement before the Niagara Frontier Section of the Air Pollution Control Association.

With deep regret we must report that **Donald S. Fraser** died on October 11, 1974 as the result of a coronary. His wife, Martha, wrote that death was instantaneous—wonderful for him but a shock for the family. To Martha and her family we send our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix Street, Winchester, Mass. 01890

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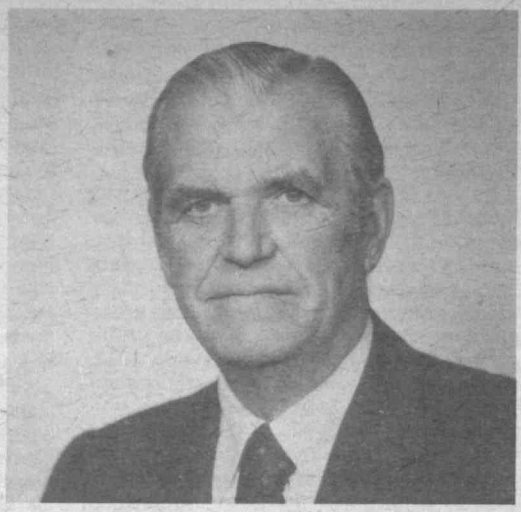
Frederic D. Merrill writes, "My wife and I took a western trip to see the Grand Canyon in early June, and in July we took a motor trip to see the Arcadia National Park in Maine. I would like to know if there are any classmates in or around Summit, Madison or Morristown (N.J.) who are interested in bicycling or hiking?" A note comes from **Richard K. Opper**: "Thank you for the birthday card! In celebrating my 67th birthday, some friends of mine brought an 8 lb. live lobster from Eastham, on the Cape, which was cooked and served for the occasion accompanied by Dewar's Scotch. Then to complete the celebration, I got myself a color TV set and a spinet piano (I am not a concert pianist—I just play to amuse myself which I have done since I was 12 years old). In June, I landed in the hospital for an operation which fouled up my planned summer trips. I expect to spend Thanksgiving weekend at the Cape and Christmas Holidays at Denver, Mass. All is well with me and hope the same to all my classmates".

Edward B. Papenfus (Canada) writes: "I am now living in happy retirement. My main interests are travel, politics and economics. I urge all my classmates to protect themselves against the erosion of paper money values by purchasing gold as soon as it is legal to do so in the U.S. The best buy is the Kruger Rand, a South African gold coin which contains one ounce of fine gold and sells at the free market price of gold plus eight per cent.

William Baumrucker, who was elected as our current president of the class at our recent reunion writes: "Doris and I are just back from a great 'business' trip. We spent one week in Egypt in conjunction with the operations for the reopening of the Suez Canal, and one week in Iran checking up on Charles T. Main engineering projects under way there. We managed to get a great deal of sightseeing as usual. Sorry to have had to miss the A.O.C. meeting. Our best regards to all." . . . **Almer F. Moore** writes: "Thanks for the birthday greetings. At this stage of the game, my birthday celebrations consists of sharing a coke drink with each of my two sets of grandchildren, and receiving two birthday cards, one from a faithful sister-in-law and one from the class of 1929, both of



John Kenneth Jamieson, '31

Multinational Oil: New Roles for an Essential Partner

"What is the future role of the international oil companies?" asks John K. Jamieson, '31, Chairman of Exxon Corp. His answer, in the Fall, 1974 issue of Exxon's *The Lamp*: "Private oil companies' skills and resources will be essential in solving the world's energy problems."

And Mr. Jamieson assured his readers that "we do not underestimate the serious nature of these problems with their profound ecological, economic, political and social implications." Change has come fast—and in large servings—to the international oil companies, and it will continue to do so. Here is a summary of Mr. Jamieson's report:

Oil companies' relations with producing and exporting countries have changed substantially. The capital invested and risks taken by international companies, in the past, enabled these companies to export and sell the oil they found overseas. The producing countries received billions of dollars in royalties and taxes for economic growth, and they also gained technical and managerial skills. The international companies built up transportation, refining, and marketing resources essential to the world's energy trade. One result for the consuming countries was that oil and gas were readily available at reasonable prices. Another was that the international companies became the only organizations equipped to perform this vital economic function.

Changes have been rapid as demand increased and supplies tightened in the past three years: a sevenfold increase in revenue per barrel to the oil exporting governments, and their ". . . significant participation in the ownership of the companies developing their oil and gas." Now these nations ". . . want their own national companies to develop their petroleum, which foreign companies must then purchase." A new environment in which to negotiate new agreements.

Many of these overseas oil-producing nations present attractive areas for exploration. Exploration involves large risks, and so the oil-producing nations are still willing to grant concessions to private oil companies which will assure the initial capital that is needed.

Hence the higher cost of crude and its products. Some industrial consumers have begun to feel that private oil companies have lost some ability to assure oil supplies at stable prices, and so some consuming countries' governments are trying to deal directly with producing countries. Public opinion that "energy matters are too important to be left to private industry" has created a push toward more regulation of private oil companies. But Mr. Jamieson thinks this an unnecessary course. Private companies will continue to expand conventional gas and oil resources, though the oil that is left in the earth (and there is plenty) will not be easy to find. Most of it is likely to be in such hostile environments as the arctic and deep offshore waters. There will be "enormous problems" and high costs. But there will be plenty of oil: "Exxon estimates that the amount of crude still undiscovered in the ground is . . . two or three times the total of all the oil ever produced in the free world before 1973. . . . Even beyond 1980, when alternative sources begin to have an impact, oil and gas will remain vitally important as major suppliers of energy."

The private companies will also continue to provide "primary trading and distribution channels" for the world's oil, though "consuming governments may be buying some oil directly from producing governments in the future." The important goal is to reestablish a stable basis for the international oil trade. The international oil companies in the future "will depend to a greater extent than ever before on their relations with governments. . . . The task over the next several years will be to find a balance—recognizing the governments' responsibilities as well as the contributions and needs of the oil companies." Within this framework, ". . . free market forces should be allowed to function to the maximum possible extent. In the long run, these forces provide the most efficient way to allocate existing supplies and call forth new supplies."

which are greatly appreciated. Like many other classmates, I am living a lazy life of a 67 year old retiree. The only activity which merits mentioning since the reunion was a leisurely and nostalgic motor trip through the mid-west. Best regards to all."

Richard E. Bolton (Canada) had just returned from a trip covering Hong Kong, Austria, and New Zealand. "It seems as if I am busier than ever", he writes, "since my retirement in 1970 when I became Chancellor of the College of Fellows, Royal Architectural Institute of Canada (three year term—furthering education)". Richard is now a "Senior Academician of the Royal Canadian Academy of Arts and Chairman of the Architecture and Planning Commission. He has two children and five grandchildren. . . . **Richard C. Wood** is still going strong with residential architecture and too busy to give in to any thought of retirement. . . . **Ralph C. Young** writes: "The only notable event that I can think of is the fact that I celebrated my 85th birthday on October 20, 1974. I was on the chemistry department staff from 1921 to 1955 when I retired, remaining as a lecturer until 1958 at which time I moved from Arlington, Mass, where I had been living, to Phoenix, N.Y. I am very much interested in all of M.I.T.'s affairs, its successes and its problems. I feel very bad that M.I.T. along with many of our private institutions of learning are having financial problems. I shall continue my modest gift of $50 annually to the Alumni Fund as long as I can." . . . Global travel is the dream of most retired persons, and as such, **Hunter Rouse** has realized this objective without even hurting his pocketbook. It seems that his professional services and talents as water resources consultant is in demand in many parts of the world. He has sent me a post card from Canton (China) which reads: "Here at last is the card I promised you. Ten of us water specialists are getting the 'red carpet treatment' from Canton to Peking, via Nanking and Shanghai and all the dams and canals in between. It is interesting to see how they build water systems under Chairman Mao. It is an astonishing country. I'll tell you about it at our 50th Reunion."

Earl H. Abbe writes: "My wife and I are enjoying our retirement. We spend our summers in New Hampshire (near our daughter and her three children), and our winters in Florida. We stop to see our son and his family on the way from north to south." . . . **Win Bearce** writes: "We have just returned (May, '74), from six months of stay at Naples, Florida, having retired May 1, 1973. Both my wife Margaret and I were told to get away from rigors of the Maine winters. On our return from Florida, we landed in Maine on April 24, in the midst of a snow storm. We had hoped to make the 45th Reunion, but it seemed that we have had enough traveling for the time being."

Alexis B. Kononoff is now semi-retired. His only business activity is a "technical consultant" to Maule Industries, Inc. at Maule-Pensurs Complex in Miami, Fla. . . . **Milton Male** writes: "My wife Maxine and I were delighted to be with classmates at the 45th Reunion and talk about the old times. If the committee can promise better weather, we will be looking forward to our 50th. Maxine and I enjoyed meeting all of you again. Our best regards to all." . . . A note from **Joseph Green** reads: "In April, '73, my wife and I went to Paris to see our youngest daughter who was studying at the Sor-

bonne. At the spring recess, for the next three weeks we traveled in six European countries: France, Belgium, Holland, West Germany, Switzerland, and Austria. We also had a five day, 500 mile boat trip up the Rhine River, from Rotterdam to Basle." . . . **James C. Coe** is semi-retired, and is doing research and publishing a number of articles on minerology.—**Karnig S. Dinjian**, Secretary, 6000 N. Ocean Blvd. Apt. 14-E, Fort Lauderdale, Fla. 33305

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At this time of year the Alumni Fund envelopes provide a helpful source of information for the Class Notes. From this source we learn that **Allen Meinecke** has recently moved from Arlington, Virginia, to Thousand Oaks, Calif., in search of an "asthma- and allergy-free area." He is interested in getting in touch with any architecture grads of his vintage. . . . **Bill Wye** writes that **Tom Hickey** retired in December, 1973, as director of the mechanical engineering examining group of the U.S. Patent Office. My records indicate that Bill is now the only one of our four Patent Examiners who is still working in the Patent Office. . . . **Jack Bloom** and **Sam Koren** retired some years ago. . . . **Jean Kresser** retired from Westinghouse in 1969, but has continued to do considerable consulting work in the field of power systems. He has made several trips to South America on large hydroelectric projects, new power systems and expansion of existing systems. . . . **Ed Rhodes** also retired in 1969 after 23 years with the California State Division of Highways. He and his wife Bernice live in Glendora, Calif. and have two children: Edward, who is working on a doctorate in astronomy at U.C.L.A., and Ada, who is employed by Morris Plan in Alhambra, California. . . . **Bill Perret** retired from Sandia Laboratories in March, 1973, and is living in Albuquerque, N.M. Since his retirement Bill has been consulting and "catching up on unreported studies ranging from theory of gauge design to analysis of ground motion data from 60 nuclear explosions. He has made two trips on the Colorado River through the Grand Canyon in recent years and strongly recommends it. Bill is president of the Albuquerque Archaeology Society and lectures on geology and geophysics at junior and senior high schools around the state. He says he doesn't expect to make the 45th Reunion but maybe will make the 50th with certain provisos, namely, "continuing good health, discontinuing lousy state of the economy and the then absence of an exciting dig or exploratory trip."

We have at hand a notice that **George M. Houston** died on August 25, 1974. Unfortunately, no details are available. My records indicate that he retired from the active practice of architecture a number of years ago and was living in Fort Worth, Texas, at the time of his death.—**Gordon K. Lister**, Secretary, 530 Fifth Avenue, New York, N.Y. 10036

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When yours truly returned home yesterday from a trip to Tokyo, Manila, Honolulu and Florida, I found a note saying that the class notes were due on November 19th . . . so I am keeping my fingers crossed in the hope that these notes are not too late to be included in the January issue. A publicity release tells that **Charles H. Norris**, Dean and Professor Emeritus of the University of Washington, received Honorary Membership in the American Society of Civil Engineers. . . . Another note from our Alumni Association says the **John A. Parker** recently retired after 25 years as head of the Department of City and Regional Planning at the University of North Carolina. . . . While in Tokyo, I had dinner with **John Minami** and his wife. John expects to retire from Waseda University in a few years. . . . **Jim Fisk** is the recipient of the A.S.M. Advancement of Research Medal. . . . **Emile Grenier** tells me that he is still fighting the proposed airbag battle because it is potentially lethal. . . . Yours truly was pleased to have been elected a Life Member of The American Society of Mechanical Engineers. Sorry but that's all the news for this month. How about dropping me a line bringing me up to date on your activities—**Edwin S. Worden**, Secretary, 35 Minute Man Hill, Westport, Conn. 06880; **Ben W. Steverman**, Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, Mass. 02158

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The time has come, the Walrus. . . . So, we're off on a brand new year. We do hope that we are forgiven for not having said our Christmas greetings in the last issue, but, written in mid-October, our thoughts were not on the holidays, so now, may we wish y'all a most happy new year, and express a hope that your Christmas was a merry one. Please write to me, now, and tell me that I am forgiven, and include all pertinent news.

This time we take off on one **William D. Harper**, of the Texas Harpers. Memory intervenes, here, to recall that the good doctor scheduled a dedication bit hooked up with a brand new building, and, forsooth, they got flooded out. Not incidentally, the building, a research center in chiropractic, has been named for the good doctor. William must be doing something right, no? Golly, it appears that William also has his bust mounted in the lobby. In the past, there has been times when we all thought he needed one! Bill announces that his book, *Anything Can Cause Anything* is now in its third edition. He mentions the story **Bill Conant** told about his family and the Stanley Steamer which, I must admit, was of real interest. Many thanks, Bill, to both you and your Bobbie. Just come see us sometime.

Next, as of receipt, is **Stan Walters**, a New Hampshire boy. Here is another guy growing trees (see December *Review*). (Not fatiguing, but time consuming.) Son John expects to grab a B.A. come January; son Tom also has expectations, but, he seems not to be in any hurry, as he takes courses at Keene State, (music?), and works as a room clerk at a local motel while serving as a musical director and organist locally. Daughter Janet has matriculated at Arcadia University, Nova Scotia. Gee, Beau has a son up thataway, too. He notes that none of the offspring have shown any interest in science and engineering. To be fair, we must admit that the old man must have taken some such interest, though his record of practice approaches mine. Gee, I missed his son Stan junior, who is an accountant with "intent to audit" at a Ramada Inn, Phoenix. Stan is still selling "capital equipment" around New England, but he is about to take a partner, so that he will have more time to write to me (Ye Scribe). How about that, you perennial laggards, why not do like Stan, just take a partner, and write to me twice a week? A.P.S. says that Stan recently had dinner in Boston with **John** and Delphine **Sterner**, who were in town on Cordis Company business. Many thanks, Stan, and you know I appreciate hearing from you, as will your classmates.

Now comes **Henry Kiley**, though I wonder if I have written this before. Henry has retired from W. R. Grace Co., after 20 years service, and is living on a small pension, plus a small estate, social security and savings, so is content and happy. His bronchial asthma is no joke, but it is obviously bearable, and he has no great complaints. Henry married his student days sweetheart, Betty, M.I.T.'32, (math). Their daughter, Mary, is married to an attorney. Henry Jr. is a captain for Western Airlines, and is happy with a profitable airline; Kevin is in insurance, in Short Hills, N.J. so is close enough for frequent visits; "Joy of My Life" Betty, is well, happy, and very active, and is enjoying Henry's retirement. I must recall that Henry and I enjoyed a couple of quickies at the Plaza one day after work and I haven't seen him since, unfortunately, I must admit that this same Henry was my close friend as a student, and still is. I do hope that Henry is not miffed with my paraphrasing his letter, as he is the modest type, and asked that I soft pedal my stuff just a bit. Henry, your classmates are entitled to the above, as you are entitled to much more from most of them. We all thank you for your story. . . . Now comes **Athelstan Spilhaus**, in a press release, where it states that he will deliver the first honors address (lecture) at the 10th Annual Conference of the Marine Technology Society. He is, and has been, very active in oceanography for many years.

As a change of pace, we insert a short bit from the Alumni Association—listing of this year's entering freshmen who have relatives who are alumni. The listing starts with the class of 1908, and, we observe that in a list of 165 names, 142 relatives et al, were of classes of 1945 and up, and only 32 from classes ahead of 1945. It would appear that the younger fellas are doing a better job of selling M.I.T. than we did.

I must mention the passing of our classmate, **Bernard Doucette**, last astronomer at the Manila Observatory, Philippines. He has no surviving relatives, so I have written to the Chief Administrator at Manila. This observatory is operated by the Jesuit Fathers, of which Bernie was a member. In fact he was a priest even as a special student in 1933. The head of the observatory tells me in a letter that Bernie was non compos for two plus years. We are saddened to hear of our friend's passing.

On November 1, I was a bit surprised to have **Westy** drop in to see me at the farm, after he had paid a visit to the Navy Yard at Portsmouth, for Ingersoll-Rand. Westy is so well known to us all, it makes it tough to get any real news from him. He did allow that he sleeps in a slightly diffent place, on Commonwealth, but still gets his mail at the same place: P.O. Box 162, Backbay Station, Boston. His future home is in some doubt as

we go to press. He seems never to change too much, as do some of us. . . . From Winnenden-Scheimenholz comes a card from **Bill Baur (II),** and Claire where they are visiting the home town of Bill's ancestors. It appears that the old town still has the remains of the old Roman wall. The Baurs spent the summer in Vermont, and the European trip will cover southern Germany, Austria, and parts of Schweiz. Bill closes with "perhaps we will meet at the next Mexico City M.I.T. Club Fiesta". Gee, Wilhelm, dot's great. I expect to make it again this year, perhaps with Leona, who is eager, but does not fly much. Thanks, Bill and Claire, We appreciate hearing from y'all. . . . Well, now, here comes **Morris Cohen** again; this time as recipient of the James R. Killian, Jr., Faculty Achievement Award, which carried with it a check for $5,000. Not bad for a po man, what? The release shows a Xerox copy of the photo of Dr. Wiesner, Dr. Cohen, and Prof. Elias Gyftopoulos, Chairman of the Faculty. Our most sincere congratulations, Morris, and again, we ask for a personal note once in a while.

We have a rather voluminous mailing from **Walt Skees**, from Spain: a few folders on fiestas, gourmet releases, et al, but, with the usual no message. The best I can make out of Walt's messages (?) is that at least he is thinking of us. Come on, Walt, you must have done something, whether or not you got caught at it. Let's have some of your handwriting, please. I am getting impatient! . . . From Raytheon we have a release concerning **Bob McCormack**, who seems to be progressing rapidly with them. Bob has been named Vice President, Manufacturing, for Raytheon, Lexington, Mass. Bob, formerly with Hygrade Sylvania, joined Raytheon in 1938, and since, has been engineer in the Receiving Tube Division, managed this division during 1955-60, became a vice president in 1960, and was general manager of the industrial components division. Bob and Catherine live in Weston, and are credited with two sons and a daughter. Now, Bob, you got the blurb, so tell me at once all about the family. I get little kick out of writing about big shots, and much more when I can write about the family and its more interesting activities. If you have a superior, tell him we appreciate getting the above story.

Now, fellas, you will note that this tends to be shorter than we would like. This is because you have sent in little material since you were scolded in the September interim letter. I admit that I did get a strong response that time. Please try to keep it up, as these notes surely depend on hearing from the faithful (?).

We mentioned in the December issue the passing of **Tom Hayden**. Now, I have a short note from Tom's widow, Louise, who tells us that Tom did, indeed, pass away in June. Louise goes on to say that Tom Jr. is a student at Dean Junior College in Franklin, Mass., and that she is Executive Secretary of the Norwood Automobile Co., Cadillac dealers. Louise, we do appreciate your short note, at a time when we had no right to expect any message. Our thoughts are with you. . . . That's it for January, except: anyone ever hear of the word, "Poitrine"? The meaning of this, and all other words may be had by writing. Ye Scribe.

—**Warren J. Henderson**, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

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The American Institute of Architecture has advanced **Armand Bartos** to Fellowship, one of the highest honors the A.I.A. can award its members. Election to the A.I.A. College of Fellows is a lifetime honor bestowed for outstanding contribution to the profession. . . . News notes from two of our classmates comes to us through the Alumni Fund Office. From **Lester A. Brooks**, "No more commuting since R. T. Vanderbilt's new corporate offices in Norwalk, Conn. were completed on schedule and we moved in June 1. The extra three hours a day plus relief from New York City and State taxes are most welcome. Am currently Product Manager for Rubber, Plastics and Petroleum Depts." . . . **Arthur L. Haskins** writes, "Recounting activities these days sounds like a broken record. I'm still Chief Estimator (New Construction) for the Bath Iron Works Corp., Bath, Maine. Also am still racing and cruising, when time permits, in my Redwing 30 C. & C. 30 ft. auxiliary sailboat. My daughter Carolyn is now Mrs. Wayne Roth and teaches third grade in Boulder, Colo. Son Dan, M.I.T. '61, heads Mechanical Engineering Department, at Franklin Institute of Boston."

Back in an earlier issue of these notes I told you of my being hired as Eastern Manager of a California company in the heat sink business to get their branch operation going here. Now it can be told that the day after I got out of the hospital from my kidney-stone surgery in July, and after I had built up a good healthy back-log of business in excess of $100,000, they let me go, having picked my brains, and are trying to get by with two lower priced persons. I am now Marketing Manager for Astro Dynamics in Burlington, a Research & Development company which has developed a proliferation of products during its 15 years. I am concentrating on developing a heat sink business there with considerable success. On a recent trip to Chicago I learned that **Boyd Brownell** has retired from his position as General Manager of the Electromotive Division of G.M.C. and is now living in Pebble Beach and playing golf frequently. Speaking of golf, **Ned Collins** won the Consolation flight of our 14th Annual Class Tournament.

Having decided to try to get the crew together for our 40th Reunion, I have set in motion plans to be very sure that I will be in good condition to row. I passed the "Small Boat Swim Test" in the Alumni Pool which consisted of swimming 100 yards then treading water for 10 minutes and believe me that was a real effort, especially since I had done no swimming since 1971. Then one warm Saturday I went out in a single scull for the first time since winning the New England Championship in 1939. Come Spring I plan to row regularly and try to get into the Head-of-the-Charles Regatta next Fall. Have a very Happy New Year and plan to be at the 40th Reunion at M.I.T. June 5—8. Will look forward to seeing you.—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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More and more classmates are retiring but those who have not seem to be as busy as ever. **Norm Copeland** had an article on the technologist's changing role in the August issue of *Chemtech.* The author is Senior Vice President and Director at du Pont. . . . **Loreto Lombardi** reports that he is now doing stress analysis of Class I nuclear piping for Teledyne Materials Research. He writes: "Learning how to feed the nucpipe program to the computer was very interesting and I really enjoy doing it." . . . **Norman Cocke** retired on June 30 and moved to Myrtle Beach, South Carolina. He is looking forward to golf and fishing "when I get a chance". . . . **Walt MacAdam** is passing his retirement serving as a consultant on problems of converting solid waste into energy. He and Rilla do a good bit of travelling. . . . Speaking of which, Class President **Tony Hitti** is in the travel agency business on the side. . . . Several class members gathered at your secretary's home in late October. Unable to attend were two "Petes". **Francis S. Peterson** was in Florida to attend the wedding of his younger son, David, who is in the Air Force after graduating from Penn. State. . . . **Lawrence G. Peterson**, on the other hand, was flat on his back in traction in St. Clare's Hospital in Schenectady being treated for an injured back sustained during the summer. By the time you read this we can hope that he is up and about. . . . A graduate member of the class, **Dave MacAdam**, was awarded the Ives Medal for distinguished work in optics at the fall meeting of the Optical Society of America in Houston.—**Alice H. Kimball**, Secretary, P. O. Box 31, West Hartland, Conn. 06091

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Bertram Wellman is now enjoying retirement in Shell Point Village, Fort Myers, Florida. He is still spending summers in Schenevus, New York. . . . **Herbert L. Shuttleworth, II**, has been elected chairman and chief executive officer of Mahasco Corp. Herb had been president of the company since 1952. He first started with the organization in 1937. . . . **Francis Houghton** is chief of Laboratories, New Hampshire Water Supply and Pollution Control Commission. He is active in church work as a lay reader and chairman of Diocesian (Episcopal) Environmental Committee. . . . **Walt Wojtezak** is now a grandfather as his son Rick and his wife had a daughter on June 15 in S. Berwick, Maine. . . . **Charles P. Witsil, Jr.** suffered a stroke about a year ago, but we are informed that he is improved and making steady progress. He retired from Dupont Co. on May 1, 1974. . . . **George M. Levy** is still in the Hardware Business and is President of the Newton Centre Business Men's Association.—**Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester M. Klashman**, Asst. Secretary, 198 Maple St., Malden, Mass. 02148

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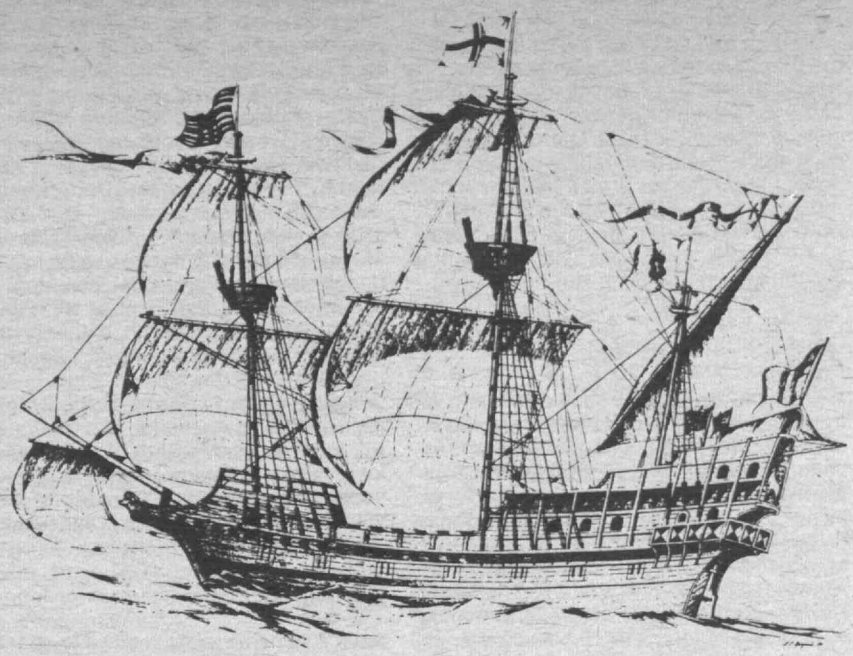
We are indebted to the Boston Evening Globe for the obituary of **Richard Lawrance** who died of cancer on July 26, 1974. Even before he went to Tech at the age of 14 he obtained an amateur radio license. At the time of his death he was the manager of magnetic equipment engineering at Digital Equipment Corp. of Maynard. He was con-



A Seafaring "Detective" Probes the 16th Century

Her sails are 4,150 sq. ft. of hand-woven flax. She is 102 ft. long, 20 ft. wide in the beam; the main timbers are English oak and elm. She carries 18 specially cast, long-barreled cannons; hand-twisted hemp ropes, rigging, and lashing; and cabin furniture of authentic hand-made Tudor designs. Centuries old? But her construction was just completed in 1973.

"It was the rigging that was the most difficult to figure out", said the man who drew the blueprints, Loring Christian Norgaard, '43, "mostly by detective work." The sleuth had to go back almost four centuries to Sir Francis Drake's legendary galleon, *Golden Hinde.* "All we had to go on," he said, "was her description as a classic 16th century warship with three masts and three decks, and built along French lines." And so he spent "hundreds of hours studying vessels of her class, sifting through records of Drake and his times, and discussing the project with naval historians." The result is thought to be an almost exact duplicate.

The *Golden Hinde II* is sailing from London to San Francisco, where it will have a permanent berth as a floating museum at Fisherman's Wharf. The trip is expected to take 150 days; the route will follow that of Sir Francis Drake—but will cut through the Panama Canal from the Caribbean. Originally sailing from England in 1577, *Golden Hinde* reached San Francisco Bay two years later.

Why the second voyage? Answers Bay area public relations man Art Blum, one of her owners: "We're approaching the 400th anniversary of Drake's circumnavigation . . . we felt an authentic replica of his ship would add to the commemoration. It's a business proposition, of course, but one which has great educational value."

Chris Norgaard is a native Rhode Islander with a seafaring heritage reaching back to old New England whaling captains . . . possibly even to the first sperm whaler out of Nantucket in 1712. As the Director of Marine Engineering at Del Monte, he is responsible for the design of new Del Monte ships and supervises maintenance of their huge fishing fleet. He also has his own naval architecture company. After designing over 100 boats—pleasure craft, passenger ships, large commercial tankers, tuna boats—Mr. Norgaard has added an unusual ship to his credit. And the *Golden Hinde* sails again.

It was under the direction of Loring Christian Norgaard, a marine architect in San Francisco, that an almost exact replica of the three-masted, 102-ton legendary galleon, Sir Francis Drake's Golden Hinde *(sketch) has been built in England—to sail to San Francisco and become a floating museum on Fisherman's Wharf.*

sidered a leader in the electronics field and was one of the developers of LORAN (Long Range Navigation). During much of World War II he worked at M.I.T.'s Radiation Laboratory, and he was an instructor in electrical engineering at M.I.T. from 1940-1941 and an instructor in physics there from 1945-1952. While at Tech he was also active in building stage equipment and developing the drama group, the M.I.T. Staff Players. He had also worked for several other firms including National Research Corp., Honeywell and the Radio Corporation of America. Mr. Lawrance was a scoutmaster in both Cambridge and Winchester and was a member of the Winchester School Committee for five years and a town meeting member there. He maintained an interest in short wave radio which dated back to his first homemade transmitter, and he could play both flute and bagpipes. He leaves his wife, Frances (Tewksbury); two sons, Jonathan and Peter Lawrance and a daughter, Wendy Lawrance, all of Winchester.

Ferdi Stern has been selected as a Fellow of the American Society for Nondestructive Testing for significant contributions to the field of nondestructive testing. . . . **Sam Goldblith** who is Underwood-Prescott Professor of Food Science at Tech has been named Director of Industrial Liaison. . . . **George Weinbrenner**, who is a colonel in the Air Force and who has been Commander of Brooks Air Force Base in Texas since August 30, 1974, was recently awarded the distinguished service medal for exceptional meritorious service in a duty of great responsibility. . . . The final item this month is the news that our 35th Reunion will be at the Chatham Bars Inn at Cape Cod on Saturday and Sunday, June 7 and 8, 1975. A number of classmates are planning to arrive earlier on Friday evening. The Committee members are **Jim** and Jane **Rumsey**, Chairpeople, **Jack** & Judy **Danforth** and **Ted** and Edith **Kingsbury**. If you plan to come please let Jim & Jane know promptly. Their address is 809 Westover Road, Wilmington, Delaware 19807. Don't forget to help support the alumni fund this reunion year. Norma and I plan to attend the reunion. Y'all come. —**Alvin Guttag**, Secretary, Cushman, Darby & Cushman, 1801 K Street, N.W., Washington, D.C. 20006

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The news of 41ers still is flowing in—**Mitch Marcus**, who is President of Production Systems, Inc. of Waltham, Mass. has been named to the Corporation of Boston's Museum of Science. Mitch and his wife, Marjorie, live in West Newton, Mass. . . . **Norm Shapira** is Director of Advanced Programs with Hydronautics of Laurel, Md. Hydronautics is a leading company in ship design, naval architecture, marine engineering and advanced waste water treatment systems. Norm retired after distinguished service as a full Colonel with the Army. . . . **Gene March** is in Pittsburgh as Group Vice President in charge of the Crucible Steel Division of Colt Industries. . . . Recently I spent a day with **Reid Weedon** in Boston. We are on the M.I.T. Nominating Committee and Reid is chairman as well as being on the M.I.T. Corporation Board. . . . **Ed Murphy** is in Pittsburgh with the Linde Division of Union Carbide Corporation. He is sales manager—on site and past president of the M.I.T. Club of western Pennsylvania. . . . **Bill Hooper** was in Pittsburgh for a while with National Steel but he is now with the Olin Corporation in Hannibal, Ohio. . . . **Howie Samuels**, fought a tough primary battle for Governor of New York State. He dealt realistically with the many complex issues and is to be congratulated, but apparently the electorate is interested in something more simplistic than the institutional reform Howie was proposing.—**Henry Avery**, U.S.S. Chemicals, 2863-600 Grant St., Pittsburgh, Penn. 15230

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Two of the class have sons beginning as freshmen at M.I.T. **Hank Stahr**'s son, John, of Greensbury, Penn. has entered M.I.T. . . . **John W. Taylor, Jr.**, of Baltimore, Md. is followed at M.I.T. by his son, David W. Taylor. . . . A note from **Alan R. Eagle** advises he has assumed the position of Director of Management Information Services at Varian Associates of Palo Alto, Calif. . . . The **Roger Barts** are on the move. Roger was promoted to Technical Director of Unbleached Products Div. of Union Camp. The family moved from Princeton, N.J. to Savannah, Ga., in August. Roger's wife, Elaine, will be a mathematics teacher at Savannah County Day School. The two younger children moved with Roger and Elaine, the two older children are away at college. . . . **Seward J. Kennedy** has resumed his traveling ways, and in August, 1974 Seward again became a Londoner. His home address is 10 Milner St., London SW3, England. Seward left Mobil Oil after 18 years, mostly in the legal department in London or Paris. He found the two years at the N.Y.C. headquarters dull, so he went with Texas Eastern Transmission Supply Div. in London. It's all new and exciting with lots of projects awaiting overseas. Seward would appreciate seeing anyone who comes to London. . . . **John L. Norton** and his wife, Priscilla, are in Greenville, S.C. John is with G.E. as test manager of the Large Gas Turbine Dept. Their son, John, Jr., has one year left before receiving his law degree from Boston University. The Nortons' daughter, Linda, is teaching English at Merritt Island High School in Florida. . . . **Lewis T. Mann, Jr.** has begun retraining as a clinical chemist and is seeking a service based position in hospital work. Research fund cuts at the University of Connecticut have made his academic base there too insecure after six years of work and research.

Ned Tebbetts has kindly reported on the Alumni Officers' Conference held last September 13 and 14 at M.I.T. The class was well represented in this large turnout of 640 alumni officers and wives. **Ned Tebbetts** from Cohasett, **Don Burke** of Florida and **Herb Hansell** from Cleveland attended, as did **Carroll Brown**, **Don Robison** and **Dick Steele**. **Bob Fried** and his wife, Lindsey, were there from New York State, and **Jim Goldstein** of New Jersey. Bob has one of his children at M.I.T. and Jim has two sons who are students. Jim Goldstein has agreed to be the Chairman for the 30th Reunion in June, 1976.—**Russ Dostal**, Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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Trust that all had a pleasant holiday season and now that we are into the essentially quiet time of the year maybe you can drop me a line as to your present activities. News this month is almost nonexistent. . . . **Ben Craig** remains as President of the Associated General Contractors of America, Alabama Branch in Birmingham. . . . **Kevin Lynch**, Professor in the Department of Urban Studies and Planning at M.I.T. has been awarded the 1974 Allied Professions Medal of the A.I.A. for his work in urban design and environmental planning. . . . **Harvey Miller** is President of NEAFCO Alloys & Equipment and his extra-curricular activities include positions as Commodore of the Charlesgate Yacht Club in Cambridge, Sergeant at Arms of the Brookline Rotary Club International, and Chairman of the Past Presidents Club of the Northeastern University Alumni Association. Until next month . . .—**Dick O'Donnell**, Secretary, 28516 Lincoln, Bay Village, Ohio 44140

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Paul Winsor III wrote that he is still Vice-President and Deputy Technical Director of Auerbach Associates, the Philadelphia computer consulting firm. Three of Paul's four children are in college this year. His oldest daughter, Sarah, graduated from College of Wooster in June and was married in August. . . . **Milton A. Widelitz** recently joined Thomas L. Karsten Associates—a consulting firm in Los Angeles as Executive Vice-President. . . . **John W. Colton**'s son John, Jr. was recently married to Donna Marie Hanson in Evanston, Ill. . . . **Robert S. McClintock** was recently named by Carrier Corp. as Zone Vice-President—Latin America. Bob is headquartered in Coral Gables, Fla. Bob is responsible for Carrier's marketing, manufacturing, and engineering activities in support of an extensive distribution organization throughout Central and South America and the Caribbean. Bob was previously employed by Hooker Chemical as area manager, Latin America. . . . **Sonny Monosson**'s company, the American Used Computer Corporation recently announced that it purchased Memorex's entire computer system's inventory for an undisclosed amount in a joint purchase from Memorex and ILC Leasing Corporation. Sonny said the inventory had an original purchase price in excess of $6,500,000.—**S. Martin Billett**, Secretary, 16 Greenwood Avenue, Barrington, Rhode Island 02808

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I hope that Christmas was a merry one for all—and that the New Year will be happy and rewarding. **Jack Baker** leads off the Alumni Fund news notes with: "Mary and I want to thank all the '49ers who took the time and trouble to come to the reunion, friends both old and new, and especially the committee that put it on." . . . **Archie Harris** announces that "Doris and I are sharing the thrills of owning our own business! After many years of working for someone else, we now know the full meaning of the "bottom line." Each month, we heave a sigh of relief when we count our receipts, pay our bills and find the bank balance is plus." . . . **William S. Hutchinson, Jr.** now represents Florida counties on the state Solid Waste Recovery and Man-

agement Advisory Council, by appointment of Governor Reuben Askew. . . . **Austin Marx** is "enjoying sunny California, with occasional trips to Greece and Guatemala, still at Hewlett-Packard (13th year) as Manager, Corporate Planning and Economics, which means assisting in looking for technological and economic changes that will affect our future." . . . **Samuel Sabbagh** is "now plant manager of Golcraft, a subsidiary of Acushnet Co., manufacturing Titleist golf clubs. Whenever any of my friends are in the Escondida area, near San Diego, drop in".

F. Cort Turner was named a vice president of Arthur D. Little in September, 1974. Since joining A.D.L. in 1952, Cort has pioneered the development of the petroleum economics work. In May 1972, he took charge of A.D.L.'s Energy Economics Section, and in 1974 he joined the Corporate special staff to lead and coordinate A.D.L.'s world-wide petroleum consulting activities. Cort is a joint '48, '49 alumni with three degrees in chemical engineering and business administration, and deserves our congratulations for a fine career and his current recognition.

Felix Haas has moved up from dean of the Purdue University School of Science to become provost, Purdue's highest-ranking academic administrator. Dr. Haas holds three degrees from M.I.T., an S.B. in physics and an S.M. and Ph.D. in mathematics. He was a professor of mathematics and head of the Division of Mathematical Sciences before becoming dean in 1962. President Hansen lauded him "a highly enthusiastic person . . . an accomplished scholar who has never lost touch with teaching." High praise, indeed. . . . **Leonard P. Richardson** is now Account Executive for the Lubrizol Corporation in Wickliffe, Ohio headquarters, with responsibility for national accounts. . . . **Rolland D. Thompson** has been elected to the College of Fellows of the American Institute of Architects, the highest honor A.I.A. can award its members, complete with gold medal.

Daniel W. Greenbaum is now executive vice president of VRS/Madigan-Praeger, Inc. A 25 year employee, he is a specialist in transportation planning, traffic and highway engineering and other areas of civil engineering design planning. Among the firm's projects are the Tappan Zee throughway bridge across the Hudson River, Dodger Stadium at Chavez Ravine in Los Angeles, and Shea Stadium in New York City. . . . That's all for this issue. More next issue. Best wishes to all.—**Frank T. Hulswit**, Secretary, c/o A.D.L., Acorn Park, Cambridge, Mass. 02140

An Artist Seeking an Impact on Society

A successful, professional artist from M.I.T.'s Electrical Engineering Department? The answer is yes—Robert E. Mueller, '48. He has exhibited extensively at galleries in New York and New Jersey, and his works are in private collections and museums, including the Museum of Modern Art in New York City.

While at M.I.T. as an electrical engineering student, Mr. Mueller studied with Gyorgy Kepes of the Architecture Department and after graduation, he continued his study of art while working in television research. Preoccupation with art did not exclude science—"There exists," according to Mr. Mueller, "a profound interrelationship between art and science. . ." His book *The Science of Art: Cybernetics of Creative Communications* (Day, 1967) explores this relationship. An example: using the electronic medium of color television to "paint and design point by point directly into the television signal. I feel that television will loom large for artists of the future, as will computer manipulation of images. . . ."

"What chance does a person have of making an impact on society? The artist, perhaps, using all the means that history provides, has a better chance than most people," writes Mr. Mueller. His huge woodcut, "America, Dream Deferred," is divided into four triptyches concerned with war, riot, repression and liberation. It can be viewed on three levels: "first, as a 17-ft. panorama in the tradition of Chinese scroll painting or the Mexican social muralist; second, in triptych sets, where the three panels form a unity of idea and design . . . and lastly, in the individual panel, so that each can stand alone . . . [an] expression of a single theme." The woodcut took three years to plan and draw, one year to cut, and Mr. Mueller will take several years to print the entire edition by his own hand.

Mr. Mueller feels that the intent of his work is to appeal, through non-symbolic imagery, to direct human emotions. ". . . The artist must above all try to shake society out of its complacency . . . I am trying, in as strong a creative communication as my temper and experience as an artist can muster, to express my impatience and unwillingness to accept the current American situation; my dissatisfaction with what I consider to be particularly evil in our society; culminating in hints of possible future outlets that seem to me to offer hope: the youth culture growing in the midst of a social manure heap like a plenum of innocent and all-consuming flowers."

Frustrations with America's current ills motivate Robert E. Mueller, '48, to create these woodcut prints as his personal protest—and his attempt to communicate his feelings to others through what he calls a "mass medium." Top: "Horsemen," bottom "Black Riders."

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Bruce R. Dixon received the Intermountain Chapter, Producer's Council Inc. "Award of Merit" for "dedicated service to his community for furthering the cooperative efforts of the American Institute of Architects and the Producers Council and for maintaining high standards of integrity in the practice of architecture". This award was received this past year. Mr. Dixon is a past president of the Utah Chapter of the American Institute of Architects and has won several A.I.A. sponsored design awards for his work. . . . **William J. Anderson** continues as chief of the Bearings and Mechanical Power Transfer Branch, N.A.S.A. Lewis Research Center, in Cleveland, Ohio. He was recently honored with the N.A.S.A. Exceptional Scientific Achievement Award (ceremony attended by Howard Johnson of the Institute) and with election to the grade of Fellow in both the American Society of Mechanical Engineers and the American Society of Lubrication Engineers.

We regret to announce the sudden death of **Robert H. Millett**. Mr. Millett was a partner in the Little Rock architectural and engineering firm of Cromwell, Neylan, Truemper, Millett and Gatchell. He designed such buildings as the University of Arkansas Science Building and Student Center and the Little Rock Municipal Airport terminal building. He was a veteran of World War II and an organizer of the Young Life chapter in Arkansas. He was also on the administrative board of the Lakewood United Methodist Church and a member of the American Institute of Architects and the Construction Specifics Institute. Mr. Millett is survived by his wife and two daughters.

Nathan H. Cook has been awarded the Blackall Machine Tool and Gage Award, given by the American Society of Mechanical Engineers, for his coauthorship of a series of papers: "Sodium Chloride Electrolyte Data at High Temperatures and Pressures"; "A Theoretical Model for High Rate Electrochemical Machining"; and "High Rate Electrochemical Machining". . . . **David E. Gushee** is the author of an article, "Plant Siting and Pollution Control", published in the August 1974 issue of *Chemical Technology*.—**John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass.

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Making it all seem like a lot more fun is this note from **Karel den Tex** of Rochester, Minn.: "Greetings from Mayo-land—stop by after your checkup and we'll dust off the stein." . . . One classmate who will probably pass this invitation is physically fit **Clark C. Abt**, president of Abt Associates, Cambridge, who was featured in a Newsweek photo of three fit and trim M.I.T. alumni. It shows him at a volleyball net.

Thomas P. Meloy has been appointed Division Director for Engineering of the National Science Foundation. He will be responsible for the N.S.F. engineering research program. The division has an annual budget of nearly $38 million and its objective is to expand understanding of basic engineering principles and facilitate translation of new discoveries into economically useful systems, products, and technology. Dr. Meloy has resigned his post as vice president for research and development of Meloy Laboratories in Springfield, Va. . . . **George Field**, now living in Newton, Mass., has, since July 1973 become Director of a new center for Astrophysics, a collaborative venture of Harvard College Observatory and Smithsonian Astrophysical Observatory in Cambridge. Children Christopher and Natasha are attending public schools in Newton. . . . **William G. Austen**, professor of surgery at Harvard Medical School has been elected a Fellow of the American Academy of Arts and Sciences.

William L. Maini, partner in Symmes, Maini & McKee, Inc., architectural and engineering firm in Cambridge, has been elected director of Commonwealth Gas Co. headquartered in Southboro and serving the southeastern Massachusetts area. He is also a vice president and member of the board of investment of the Cambridgeport Savings Bank. . . . **Clifford J. Kronauer**, General Manager, Technical and Support Services Department, at General Electric's Valley Forge Space Center, has been appointed to the Board of Directors of the American Defense Preparedness Association, Philadelphia Center. . . . **Frank H. Thomas** is Vice President and General Manager of Turner Construction Co., nationwide general contractors. He resides in Wheaton, Illinois, and his family includes four children. Frank is a member of the Chicago Panel of Building Skill Training and Career Development program of the Building Research Advisory Board of the National Research Council. . . . Reelected to a five year term as member of the M.I.T. Corporation is **Breene M. Kerr**.

Special interest department: Among new students this year, eight have fathers who graduated in '51, one whose uncle was a '51 graduate; and of particular interest is the case of Armando Garza-Sada of Monterrey Nuevo Leon, Mexico, who has three uncles, a father, grandfather, and granduncle, all M.I.T. graduates dating from 1914 to 1961. Uncle Bernardo graduated in '51.

Herbert R. Graham has moved from Los Angeles to become Technical Staff Assistant to Project Manager of Denver Transportation Project for T.R.W. . . . **Malcolm Whitlock**, who joined Ethyl Corp. in 1965 as Manager of Projects, Ethyl International, has been promoted to General Manager, International Petroleum Chemicals in Baton Rouge. This is a newly created position in the International Group of Ethyl Corporation. . . . Another new effort is by **Burton W. Dempster** of Norristown, Penn., who is providing market consulting services to companies introducing products in the field of computer and data communications equipment. This follows 20 years as a manufacturers' representative for this type of equipment. . . . While we are on the subject of new ventures, we will report on **Charles H. Fargo** who is president of newly formed firm of C. H. Fargo & Co., an industrial, commercial and investment real estate brokerage firm in Boston with an additional office at Plymouth. For 19 years he was Senior Vice President and Manager of Industrial Division of Hunneman & Co., Inc.

Anyone wanting to start a new business might check with **William H. Ramsey**, Newton Center, Mass., Associate Director of the Institute for New Enterprise Development. This institute assesses talents of aspiring entrepreneurs and guides them toward successful development of new business ventures. It has developed a library of 6000 product and process ideas and has access to corporate, government and university sources of items available for acquisition or license. Weekend workshop sessions are conducted by a team composed of a behavioral scientist, business school professor, and a venture capital analyst, all with many years' experience with new ventures. Bill is also manager of an O.E.D./I.N.E.D. program to develop new enterprises through community development corporations.

Suggestion box item: **Francis Parker** writes "Enjoyed reading XIII Newsletter. Suggest more information about the Marine Data Systems and Design Lab in *Technology Review.*"

We regret having to report of the sudden death of **Edward G. Fitzgerald**, a self-employed engineer, living in Los Angeles. He is survived by his wife and daughter.

Willard B. Ferguson is now Manager of Customer and Marketing Services of U.S. sales for the Instrument Marketing Division of Perkins-Elmer Corp. in Norwalk, Conn. This division develops and manufactures chemical analytical instruments for use by industry, governmental laboratories, in hospitals and universities throughout the world. . . . **Daniel D. Sullivan**, architect, is still commuting between Cape Cod and St. John, U.S. Virgin Islands, and busy sprucing up the century-old Provincetown Town Hall for the Bicentennial. His wife, Louise, is a licensed real estate sales person and also manages the Sullivan resorts on the Cape and in St. John. David, 13, and Peter, 17, are attending Seaford College in Sussex, England.—**Fred W. Weitz**, Secretary, 4800 S. W. 74th Street, Des Moines, Iowa 50309

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Fellow 1953ers: Sorry to learn that your writer's cramp is so bad that not even one of you could drop me a line. After all the bitching and complaints about lack of 1953 notes (before my time, *of course*), etc., etc., etc., it seems to me that you can at least hold up your end of the bargain. Therefore, please write—*anything*, even about your mistress (or lack thereof), money (ditto), dreams (ditto), or, alas, work (ditto).

Two news blips: *Business Week's* June 22nd issue paid photo tribute to three fit and trim M.I.T. alumni in an article giving pointers on physical fitness. Among the three was **Franklin Jarman**, Chairman of Genesco, Inc., Nashville, Tenn., who was shown jogging into a turn. [Ed. Yuck! I'll stick to my own "devices."] . . . MITRE Corp. reports that **John Guppy** has been promoted to the D-93 Department Staff at Beford. In his new position, he is to be available to several projects in D-93 as a switching consultant, in addition to his continuing involvement with the Automatic Voice Network (AUTOVON). John joined MITRE early in 1960 and worked in air traffic control and systems integration for five years before joining the AUTOVON program in 1965. Prior to his MITRE association, he had been a member of the Bell Telephone Laboratories staff for six years.

Since there's no other news, will add the following filler about dear ole me. After some difficult decision-making (in which I was trying to choose among a vacation in St. Thomas, a new "roommate", a Porsche, or a house), I decided on the last of the four; basically, the "upkeep" costs are smaller and deductions higher. Bought a crazy modern townhouse with all the trimmings (or, should I say, "trappings"); would drive a sane person nuts—but will have little effect on me or my current crop of friends. Feel free to drop by for a visit—but bring money, booze or warm feet. 'Tinny rate, Merry Christmas to all.—**Martin Wohl**, Secretary, 7520 Carriage Lane, Pittsburgh, Penn. 15221

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Carole and **John (Pete) Peterson** were in Boston this summer with their daughters Melissa (15) and Jennifer (12) for a New England sightseeing vacation. Pete has been with B.F. Goodrich now for nine years, most recently in the International Division. Dropped in on Judith and **Dean Jacoby** who gave them the two-bit guided tour of Concord, Mass.

Philip James has been named Director of the University of Southern California's Idyllwild campus. He plans to utilize his broad background in higher education, to develop a high quality year-round academic program there. Philip had recently been executive assistant to the chancellor at U.S.C., San Diego. . . . Locally, **Dean Jacoby** is chairing the Concord-Carlisle Community Chest and **Bob Evans** is back on the school committee in Acton. . . . **Wally Boquist** recently kicked off his new class presidency with a meeting of class officers. **Lou Mahoney**, **Dean Jacoby**, **Bob Evans** and **Dave Howes** attended, along with a representative of the Alumni Fund. As many of you are aware, it is traditional for each 25 year class to give a substantial gift to M.I.T. Since our next reunion is number 25 and since we as a class have not set any new records for enthusiasm, it is not too early to address this subject. Hence, the meeting, which was the first in a series. . . . **Dean Jacoby** has agreed to serve as a Vice President and **Bob Anslow** (in California) will be Class Gifts Chairman. Obviously they are going to need help in fund raising and volunteers are requested.

One of the proposals designed to spark class interest is the publication and distribution to all classmates of a class directory which would be updated at intervals as

data are received from class members. Another possibility is a series of mini-reunions at locations across the country. Ideas, suggestions, and feedback are solicited from all of you. Please respond early so that your inputs can be included.—**Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741; **Chuck Masison**, 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney**, 14 Danby Rd., Stoneham, Mass.

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The prelude to this issue's notes about your classmates is a summary of the peregrinations of the Twentieth Reunion Committee. In response to the wishes of the majority of those returning last years questionnaire, Martha's Vineyard has been selected as the site. **Paul Attridge** and **Rick Morgenthaler** have contracted with the Harbor View Hotel for accommodations and meals for June 6 to 8. It really looks good; we'll practically have the hotel to ourselves, there's a heated pool, and the plans for transportation, from Boston, the banquet, and the parties are all falling into line. We expect to hold the price to our original estimate ($140 for everything) or maybe a little less. M.I.T. will provide no-cost lodging for the night of the 5th, so make your plans now to attend. You'll hear more from the Committee shortly.

Gordon B. Pye has joined the Irving Trust Company as a senior economist and vice president of the bank's economic research and planning division. He is formerly an economic consultant for Standard Oil of California and a professor of business administration of the University of California at Berkeley. . . . **Richard M. Connell** has been promoted to Brigadier General in the U.S. Army. He has been the Engineer of the U.S. Army Training and Doctrine Command at Ft. Monroe, Va., for the past year. A 1949 West Point graduate, he has served in Europe, Viet Nam, and Labrador, as well as the U.S. He and his wife Betsy have two children.

Boyd Kendall, who retired from the U.S. Coast Guard with the rank of Captain, heads the ocean engineering program at California State University, Long Beach. This program, which is the only undergraduate curriculum of its kind on the west coast, was accredited by the E.C.P.D. in the fall of 1974. . . . **David M. Scott** has been advanced to Fellow of the American Institute of Architects. This honor, bestowed for outstanding contributions to the profession, was awarded at the AIA convention.—**Allan C. Schell**, Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Seen at the Alumni Officers Conference this fall was Merlin Lickhalter, '57, Executive Vice President, The Drake Partnership, Architects, in St. Louis; **Warren Briggs**, Associate Professor at Bentley College; and **Ed Baker**, who is practicing tax law in New York as a partner in a firm. He writes and lectures extensively for accounting and legal groups, is a former president of the Northern New Jersey Club and serves as an educational counselor. Ed indicated **Jack Rosenfeld** is at I.B.M. and **Howard Bertan** has started a company concerned with power controls located on Long Island. . . . **James Bjorken**, Professor of Physics at Stanford, has been named a Fellow of the American Academy of Arts and Sciences. . . . **John Clancy** of the firm of Moody and Clancy, Inc. is winner of the first Massachusetts competition for state-subsidized public housing for the elderly. . . . **Mort Cohan** writes that he was elected to the Marlboro, N.J. township Board of Education last February after serving on the Zoning Board for several years. In addition, Mort just started with Schering after five years with Squibb, still working in pharmaceutical research and development and computer systems.

At M.I.T., **Kreon Cyros** holds the dual positions of Associate Director, Planning Office, and Director, Office of Facilities Management Systems, a newly formed group concerned with a facilities inventory system he developed. . . . **Steve Freedman** has been appointed Assistant Director for Power and Combustion, Office of Coal Research, U.S. Department of Interior. Steve had been Vice President, I.U. Energy Systems. . . . **Ted Korelitz** presented a paper on distillation at the A.I.Ch.E. meeting in Munich in September. A few weeks later, he, Diane, and children were living in the Hague while Ted is on special assignment for Badger until next September. . . . **Robert Mansperger** oversees testing, evaluating, and exploratory research as manager of research engineering for the Warner and Swasey Co. in Cleveland. . . . **Sven Vaule** has been named Vice President of Jones & Vining, but remains as Chairman of the Board of Vaule & Company. . . . **Lamar Washington, Jr.** has returned to the Institute as General Manager of the Innovation Coop, part of a new Innovation Center designed to provide students with experience in inventing and bringing new products to the marketplace.—**Bruce B. Bredehoft**, Cosecretary, 2 Knollwood Dr., Dover, Mass. 02030; Mrs. **Lloyd Gilson**, Cosecretary, 35 Partridge Road, Lexington, Mass. 02173

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Harold Miller has been promoted to the position of Vice President and Director—Operations for I.T.T.'s Defense Communications Division. After leaving M.I.T. he was a mechanical engineer with R.C.A. in New Jersey. From 1958 to 1964 Harold was a project engineer at the Air Force's Rome Air Development Center in Rome, N.Y. He joined I.T.T. in its Avionics Division. . . . **Peter Samton** dropped us a note to say that B. Sumner Gruzen, founder of Gruzen and Partners—the firm with which Peter has been associated, died in September. He had been retired for several years. The firm continues as a partnership comprised of six partners, three of which are M.I.T. grads—**Jordan Gruzen** (son of the founder), Rolland Thompson, '49, and **Peter Samton**. . . . Over ham and swiss sandwiches and a beer I had a very interesting conversation with **Mike Brenner**. Mike heads Brenner Associates, a recruiting firm specializing in financial executives, and is located in the Pan Am Building just a few steps from the Mobil Building in midtown Manhattan. Mike gave me a little rundown on his activities since leaving M.I.T. He spent his first eleven years in the field of operations research getting his Ph.D. and working at the Bell Labs where he headed a fifteen-man department. He wanted to move into broader management work and for a first step, left Bell Labs and joined New York University, where he taught various management courses and engaged in consulting. Some of his consulting was operations-research related but it also extended to various venture capital projects, a very interesting assignment dealing with the Bahamas Telephone Company, and work with a personnel agency. It was through this latter assignment that he moved into a position with a privately-owned personnel agency (as Executive Vice President) where he remained until 1973. Mike then started Brenner Associates. It was a very tough job getting established but he now feels he has substantial momentum. Mike has developed on-going relationships with Xerox, Fairchild, Nabisco, various major New York banks, and other substantial companies. Mike recently had an article published in MBA, a magazine for people in financial management. It is a very interesting article dealing with the psychological aspects of changing jobs. I am sure Mike would send anyone requesting it a copy of his article. Mike passed on the news that **Marty Gerson** is now associated with Loeb Rhoades down on Wall Street and that **Harry Flagg**, after a lengthy sojourn with his family in Europe, is back in Hawaii. Mike, who lives in Brooklyn Heights, is going to help me with the organization of our class cocktail party for New York area classmates. I am scheduling it for Friday evening, January 17 at our apartment on Riverside Drive.—**F. L. Morefield**, Secretary, 285 Riverside Drive, N.Y., N.Y. 10025

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Greetings to all as we start a new year. A few items received in Boston: **Samuel Fryer** was recently appointed Manager of Chemicals for Skelly Oil Company with responsibility for coordinating operations of the company's chemical subsidiaries. . . . **Bill Widnall** has been named as the A.I.A.A.'s first Congressional Fellow and will be serving on the staff of the House Science and Astronautics Committee with a focus on Space Shuttle payloads and energy problems. Following his graduate work at the Institute in electrical engineering and aeronautics and astronautics, Bill worked on navigation guidance and control systems at the Draper Laboratory (né M.I.T. Instrumentation Laboratory) before joining Intermetrics where he continued work with inertial navigation systems.

I was recently in Chicago and had a pleasant lunch with **John Amrein** who, continuing our policy of input from different areas, writes: "The list of Chicago area '59ers is short. The venerable computer lists only 24 of us among a total Chicago-area alumni population of about 1200. Here are reports on four of the 24, all living in suburbs north of Chicago: **Larry Broutman** spans most of the Chicago area on a daily basis, living in the village of Glencoe at the far north and working at the Illinois Institute of Technology on Chicago's south side. Larry is a professor in the Department of Metallurgy and Materials Engineering, and divides his time among teaching, research, and consulting in the fields of plastics and reinforced plastics. He is also Secretary of the Society of Plastics Engineers. Larry and fellow '59er **Dick Krock** (who lives in Burlington, Mass.) are editors of a new eight-volume series on *Composite Materials*, published by

Academic Press. Larry has lived in Glencoe for the past six years with his wife and two children, a son (12) and a daughter (nine).

Just west of Glencoe, in Northbrook, **Seiji Itahara** lives with his wife and two children, a daughter (six) and a son (four). Seiji is Director of Engineering Services at Reflector Hardware Corp., which manufactures fixtures and displays for retail shoes. Seiji's responsibilities include product engineering, plant engineering, data processing, and cost accounting. He came to the company and to the Chicago area four years ago from New Jersey, where he worked as a chemical engineer for American Cynamid.

To the south of Northbrook and Glencoe, and just north of the City of Chicago, is Evanston, where **Bruce Blomstrom** lives with his wife and children, a son (nine) and daughter (six). Bruce is Corporate Planning Manager at Abbott Laboratories located well north of Chicago in the town of North Chicago. He is responsible for devising business strategies for the corporation, including acquisitions and special problems. Bruce has held this position for about a year. He previously spent several years with Libby, McNeill, and Libby in Chicago. Last July, Bruce was appointed by Governor Dan Walker to serve on the Illinois State Hospital Facilities Planning Board, which deals with the allocation of federal money in building health care facilities around the state. Bruce is also President of the International Visitor Center in Chicago, an independent organization that entertains State Department visitors in the Chicago area.

Moving back north from Evanston to Glencoe, I will close the circle with a brief description of my own activities. In January of 1974, I formed a small company called E. J. Amrein Professional Associates, Inc., to do adult continuing education. I am now attempting to expand somewhat by also offering editorial and design services to publishers in the Chicago area. Until this venture gets off the ground, I work full time from my home as a professional writer and editor, specializing in educational materials. Prior to all this, I worked as an editor and manager in three major textbook publishing houses in Chicago, and spent four years as a high school physics teacher. Currently, during my "spare" time, I am active in the M.I.T. Club of Chicago (president last year) and a member of the Chicago area M.I.T. Alumni Fund. In the midst of everything else, I somehow find time to spend with my wife and two children, a daughter (ten) and son (seven)."

We look forward to hearing from more '59ers without having to wait for five year reunion intervals. When you have a chance, please drop a short note to **Phil Richardson** at 180 Riverside Drive, New York, N.Y. 10024, **John Amrein** at 770 Greenwood Avenue, Glencoe, Il. 60022, **Bob Muh** at 907 Chantilly Road, Los Angeles, Calif. 90024, **Adul Pinsuvana** at 49 Seri Road, Seri Village, Hua Mark, Bangkok, Thailand, or myself.—**Allan Bufferd**, Secretary, 8 Whitney Road, Newtonville, Mass. 02160

61

Happy New Year! I trust that Santa was good to you all and that the new year will treat you well. We ended the year with a little mail from you people which follows; **Steve Salomon**, a regular correspondent, writes: "During the last year that I have been with the A.E.C. I have survived the environmental crisis, the energy crisis and the financial crisis. Now I am no longer with the A.E.C. since we have changed our name. The regulatory arm of the A.E.C. is now called the Nuclear Regulatory Commission. There should be plenty of interesting work for us in the year ahead." . . . Another of my old friends, **Marshal Greenspan**, also sent a note. He writes that he is working for the Norden Division of United Aircraft in Norwalk, Conn. Marshall says that he is chief of systems analysis which puts him in charge of about 30 people who are simulating and modeling various systems like radar and surface to air missiles. They are also working on E.C.M. systems—whatever they are. . . . Another leader among men is **Alan Weinberger** who is the manager of Computer Systems Programming at Sperry Rand in Reston, Va. . . . **Romney Biddulph** is, you guessed it, the Manager of Financial Operation Analysis for Sperry Rand in Blue Bell, Penn. Romney and Alan should get together and compare managerial notes.

Hank Wagner was my last letter writer and he said: "I am living in Parsippany, N.J. with my wife Margie and four children ranging in age from two to 12 (two boys and two girls). I am the Manager of Business Planning for the Allied Chemical Corp. I've been with Allied for six years now. As middle age approaches I am now hitting a tennis ball rather than a baseball but not any better at tennis than I was at baseball." Thanks for the letter, Hank. . . . I saw a copy of a new book, *Entrepreneurship: Playing to Win* by our own **Gordon Baty**. The cover says that the book will tell us, among other things, how to operate without capital and how to "divest people." The blurb on the back tells us that Gordon is a part time lecturer in a graduate "New Enterprise" course at Northeastern University. This is Gordon's first book. Is it the class' first book?

An interesting press release from Lake Forest College, in Illinois, says that **Francisco Sosa** is a new assistant professor of Spanish. Francisco has really been around the academic world. After the M.I.T. S.B. he got an M.A. in French at the University of Nebraska in '67 and an M.A. in romance linguistics from Yale in '68. Finally he got a Ph.D. in romance philology from Yale last year. Along the way he was a teacher at Wayne State and California State colleges. Wow! . . . Two other M.I.T. academic types are also in the news. **David Baltimore** is a new Fellow of the American Academy of Arts and Sciences while **John Deutch** is a Guggenheim Fellow. . . . Finally, we had lost track of **Pete Gray** until this press release arrived saying that Pete is now the Deputy Administrator of courts for the state of New York. Pete had been the Deputy Director of the New York City Criminal Justice Coordinating Council before this advancement. . . . Keep the letters coming—I'm getting lonely.—**Andrew Braun**, Secretary, 464 Heath Street, Chestnut Hill, Mass. 02167

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Rudolph H. Gawron has been transferred by G.E. to the Information Services Business Division in Bethesda, Md., as a Senior Technical Specialist. He and his family are really enjoying their new home in Silver Springs, Md., and he is finding his new job to be very challenging and interesting. He is hoping to "stay put" in the Washington area for some time. . . . **Modesto A. (Mitch) Maidique** has been appointed Vice President and General Manager of Analog Devices Semiconductor. In his new position, Dr. Maidique will be responsible for the complete operation of the Analog Devices Semiconductor Division which employs 170 people domestically and about 100 overseas. Dr. Maidique and his wife Eulalia live in Lexington, Mass. He is a member of Tennis 128, The Greater Boston Real Estate Bd., Sports Car Club of America, and the Porsche Club of America. They have two children, Ana Teresa, eight; and Mark Alex, three. . . . **Theodore J. Sheskin**, is living in Teaneck, N.J., and on August 31, 1974 received his Ph.D. in industrial engineering and operations research from Pennsylvania State University.—**Gerald L. Katell**, Secretary, 7 Silverbit Lane, Rolling Hills Estates, Calif. 90274

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I have no mind boggling statistics for you, nor any deep philosophical thoughts. This month it's just news. I have noticed one strange phenomenon in the year plus that I have been writing these notes. With only one or two exceptions the letters I receive directly come either from classmates living abroad, or those who have just returned from abroad. Those of you living within the U.S. communicate primarily by means of Alumni Fund envelope flaps.

This month's letter came from **Toby Zidle**, and I believe it must get the long distance award. Toby writes from Australia: "After eight years of petroleum exploration with Amoco Production Co. in Houston, I have made the big jump and gone international. I have joined Arco International Services and have been assigned to Arco Australia Limited in Sydney as Senior Geophysicist. My wife Marcia and I are thoroughly enjoying the Australian springtime, along with the wild parrots and cookaburras that visit our back yard. Four year old Melissa Allison has decided that she likes Australia 'medium'. And we have all been kept quite busy by our own native Aussie, Heather Michelle, who was born here on July 18, 1974." Toby sends best wishes to the rest of the class. . . . Another overseas correspondence came from **Harold Solomon**, who is at the University of Tokyo. The message, a change of address card, was written in both English and Japanese. Harold's new U.S. mailing address is 4040 Cromwell Ave., Los Angeles, Calif. 90027.

Please don't infer from my comments above that I am knocking the envelope flap as a communications medium. I'd have very little to write if you didn't keep filling out those flaps. With that intro I give you the following: **Steven Bernstein** writes that he is living in Lexington with his wife Stephanie and daughter Deborah, three. Steve is now assistant leader of the Communication Systems group at Lincoln Labs. . . . **Fred Cunningham** reports that his first child, Heather, was born October 13, 1973. He is president of a company that owns a 60 acre farm. . . . **Bruce Eisenstein** has joined the ranks of the home owners, purchasing a ten room split-level in Wyndmoor, Pa. Welcome to debt, Bruce—it's a painless condition. Bruce is still teaching E.E. at Drexel Univer-

sity and wife Toby is teaching at Temple Medical School. The Eisensteins have two boys, Eric, three, and Andy, two.

From **Jim Evans** we hear that **Alan Marty** was married on August 11, 1972 to Marie-Paule Ruebenze whom he met in Greece. Alan is now finishing residency in Cardiac Surgery at Cedars Sinai Medical Center in Los Angeles. Prior to that he spent three years at Peter Bent Brigham and two years at San Diego. . . . **Stephen Fisher** updates us on his recent history. He got his Ph.D. from the University of Wisconsin in 1967, and was an instructor in the math department at M.I.T. from 1967-69. He is currently associate professor of mathematics at Northwestern University. . . . **Tony Geisler** is still married to Dee, and has two blue-eyed, blonde, daughters, Becky, three, and Wendy, one. He is still product manager in the food division with Mallinckrodt in St. Louis and is living the typical suburban life in Ballwin in west St. Louis county. . . . **John McNally** obtained an M.B.A. two years ago and has made the switch from research to commercial development. He is living in the Pittsburgh area and writes that he hasn't seen or heard from any classmates in a long time.

Ken Klein is still single, and living in Forest Hills, N.Y. He is working at C.B.S. as an information systems associate for the television stations division. "Even though I graduated in course XVI," writes Ken, "computer systems seem to provide more future for me than the aerospace industry." Amen. . . . Renee and **Lewis Shulman** announce the arrival of daughter Susan Lisa, December 13, 1973. . . . **John Lamberti** sent the following note, "Having completed my training in cardiac and thoracic surgery at the Peter Bent Brigham and Children's Hospitals in Boston, we (wife and two daughters ages five and three) moved to Chicago. Thus ended an eleven year love affair with the city of Boston. I am assistant professor of surgery at the University of Chicago School of Medicine." . . . My final flap was a query from **David Claypool**, asking whether he had sent me a note earlier this year. No, you didn't Dave. But, if you do send me some details on your recent history, I'll get it into print.

By phone I got the following information from **Bjorn Conrad**: **Paul Abramson** is the father of 1.8 children. (Actually that phone call was back in September—by now it must be a full 2.0.) Bjorn also had lunch in Chicago with **Frank Fradin** who at that time was on his way to a three week paper giving stint in Europe. The Conrads and the Bertins lived across the street from one another during the three years from 1968 to 1971, and it is with some small bit of sadness that I note that Bjorn and Joyce have now deserted the old neighborhood in Menlo Park, California, and moved to a classier neighborhood in nearby Portola Valley. However, I am sure that the Conrads are enjoying their new, larger house.

I'll conclude with a couple of press releases: **Howard Leibowitz** has been appointed manager, heavy duty machine systems, at Corning Glass Works in Corning, N.Y. Howard has been with Corning since 1965 serving in a variety of engineering positions. . . . **Jim Champy** has been re-elected to a second five year term as a member of the M.I.T. corporation. . . . **Robert Efimba** received the Moisseiff Award from the American Society of Civil Engineers. Robert and several other M.I.T. alumni were honored for their paper, "Some Structural Problems: Standard Oil of Indiana Building." The award memorializes Leon Moisseiff, a notable contributor to the art and science of structural design.

Ladies and gentlemen, that exhausts my backlog of news, notes, etc. My Old News File is very old—most of it from 1972 and before. Unless you want to read really ancient history in these pages in the coming months you had better get me some envelope flaps. Hope you all had a pleasant New Years.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92664

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Happy New Year Class of '64. Please remember M.I.T. kindly in your donations this year. Money is tight for everyone these days, but the educational process that got most of us started on our careers must be continued for others today, and our generous help is required to the maximum extent possible.

And now to the purpose of this column: class notes. **Ronald Alpert** is now the Assistant Manager of Basic Research at Factory Mutual Research Corporation. His daughter, Audrey Jane, celebrated her first birthday last June. . . . JoAnn and **Ed Arnn** are enjoying the pleasures and challenges of parenthood with their year old daughter Nicole. . . . **Robert Fischer** is a Foreign Affairs Officer with A.C.D.A. . . . **James Harrill** has been selected for promotion to Lieutenant Colonel. He is presently the Commander of Air Force ROTC group at Syracuse University and is scheduled for reassignment this summer.

Robert Hill informs us that he is head of the high power laser section at Hughes Aircraft Company. His wife, Gabrielle, completed her masters in Radiopharmacy at U.S.C. while he enjoyed the football team's successes as a "spouse of student". . . . **David Holden** is producer/director of a series of films for foreign television. . . . **David Patterson** is on assignment as Petroleum Officer at the American Embassy in Tehran. His wife, the former Sue Hartshorn of Denver, a career Foreign Service Officer, is assigned there as a vice consul.

Larry Rabiner has written a textbook *Theory and Application of Digital Signal Processing* which is published by Prentice-Hall, Inc. and is available as of January, 1975. He is currently President of the I.E.E.E. Group on Acoustics, Speed, and Signal processing. He and his wife are also enjoying their two daughters Sheri and Wendi. . . . **Edward Shibata** is an Assistant Professor at Purdue University in the Department of Physics. He was married last year to Fran Hatch, a Saugus, Mass., girl who he met at the very first Purdue football game he attended. . . . That's it for this month. Have a good year and remember to write. We need news for our class notes. —**Steve Schlosser**, Secretary, 15 Apple Hill Road, Peabody, Mass. 01960

67

Karnig S. Dinjian, secretary for the class of 1929, has forwarded a class note from **Bob Landley** that had been sent to him by mistake. Karnig writes that he was surprised by the content of the class note until he realized that Bob is in the class of 1967. "Not realizing that he is not a member of the Class of 1929, when I reached the portion of his note that says 'Due to have third and last child in July. . .', I thought I had come across a member of our class who, genetically speaking, belonged to a super race. Than I noticed that he belonged to the class of 1967 and not that of 1929." Bob has been with General Electric in Daytona for six years, and he and his wife are building their house. . . . **Ted Tenny** writes: "I have some good news for the Class Review! On September 21 I married Jacquelyn Vestal, of Red Bluff, California. Jacque and I are living in Mountain View and I'm still working at Lockheed as a computer programming instructor. Last June ('73) I received my M.S. in computer science from Stanford, my second master's degree from that institution. My real ambition is writing, though, and I got a lot of satisfaction from having an article published in the July, 1974 *Datamation*." . . . **Ed Geltman** is an instructor in a physicians assistant course at Sheppard Air Force Base, Texas. . . . **Ken Barbour** is a du Pont process engineer in Delaware. . . . Sue and **Dave Lapin** have moved to smoggy southern California where they work for Burroughs Corp. They are developing software for a system that should see the light of day in about three years.

Joel Speare is now at Raytheon Spencer Laboratory. He has two sons. . . . **Lane Schelber** is a member of the research staff of the Institute For Defense Analysis in Arlington, Va. . . . **Joe Ferreira** will receive a Class of 1972 career development professorship. Joe is assistant professor of Operations Research and of Urban Studies at M.I.T. . . . Last April **Carl Doughty** married Chungna Yoon, a native of Korea. . . . The final (?) score in the **John Howard** household is girls-3, boys-0. John's latest daughter arrived April 21, 1974. John is a manager of product development for Dynatech Laboratories Inc. . . . After a post-doctoral year at Caltech, **Isom Herron** has joined the faculty of Howard University as an Assistant Professor of Mathematics. . . . **Alan Hirsch** and Ken Dritz, '66, spent sixteen days floating down the Colorado River and hiking in the Grand Canyon last June. Bachelor Alan enjoys his work with Standard Oil of Indiana. . . . Since receiving his M.S. from M.I.T. in 1972, **Joe LaBreche** has lived in Florida where he is Director of Finance for Killearn Properties. He is married to Betsy Gage, Simmons '69. . . . **Paul Caragine** is in his third year of orthopaedic surgery residency at New Jersey College of Medicine. After his residency, Paul will return to his home town of Boonton, N.J. to practice. He is now the team doctor for the Boonton High School football team. . . . **Don Davis** is an assistant professor in Lehigh University's department of mathematics. . . . **Bill Hsu** is an assistant professor in engineering at Swarthmore College.—**Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

69

I have received only a few notes from our classmates since the last installment of this column so take out some time this winter and drop me a line. In the meantime, I hope you have a happy and prosperous new year.

Jeremy K. Raines received his Ph.D. in electromagnetics from the M.I.T. Depart-

ment of Electrical Engineering last year. Since September 1973, he has been running his own engineering firm in Silver Spring, Md. His business is called Technovators and specializes in antennas, arrays, broadcast systems, and blue-sky projects in electromagnetic theory. At the time of writing, Jerry was studying for an exam so that he could become a licensed professional engineer in Maryland and California. . . . **Arthur J. Saffir** is now the director of oral health research at Cooper Laboratories. . . . **Jeff Geier** reports he is living and working in Reading, Mass. His work at the Analytic Sciences Corporation involves statistical modeling and application of modern estimation. Jeff's son Ian is now five years old. . . . **George L. Claflen, Jr.**, has been appointed to the architecture faculty of the College of Engineering Technology of Temple University. In 1974, George received masters degrees from the University of Pennsylvania in architecture and city planning. His studies were conducted under a joint program in urban design. His previous professional experience includes teaching at the Boston Architectural Center and at the University of Pennsylvania, working on an education center at Babson College, various additions and renovations involving a public school in Brookline, Mass., and satellite school facilities for a Navajo Indian community in Rough Rock, Ariz.; and serving as an intern in urban design for the City of San Francisco's department of city planning.

Several messages during the past year indicated that some letters and notes from classmates have not appeared in this column. I apologize for this apparent omission but, unfortunately, some of the notes may have been lost during the handling of the notes or their preparation for use in this column. In addition, a few notes have had illegible names or no names at all. Accordingly, if you have sent in notes but have not seen your name in print, please drop me another line at your earliest convenience. For those of you who use the convenient form on the back of the Alumni Fund envelope, please be sure to print your name clearly and specify your class year. This information expedites the handling of your notes while helping to ensure that they are directed to me for inclusion in our class notes column. Hope to be hearing from you! —**Richard J. Moen**, Secretary-Treasurer, 4008 IDS Tower, Minneapolis, Minn.

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Our classmates continue to maintain ties with the academic life: most of the people we've heard from recently are either in graduate school or have just received degrees or faculty appointments. **Jane E. Karp** entered Case-Western Reserve Medical School in September. . . . **Larry Azevedo** will soon receive his Ph.D. in physics from U.C.L.A. He and his wife have taken up bicycle racing, "a very exciting sport". . . . **Steve Cooper** writes that "being an intern is almost as hard as being a tool at the 'Tute. I actually miss Boston since I'm having nowhere near the fun I'd thought I would in L.A. Never get enough time off to enjoy the place." Steve occasionally sees **John Huchra**, who is still working on a Ph.D. in astronomy at Cal Tech, but expects to finish around March 1975. John might then be going to Australia, to Mt. Stromlo Observatory. . . . **Stanley Schwartz** graduated from the University of Connecticut Medical School in June 1973, and is an intern in pathology at Strong Memorial Hospital in Rochester, N.Y. Stanley is now married to Naomi Resnick (Wheelock '74). . . . **Wayne R. Porter** has finished his internship and is starting a residency in internal medicine. His eventual goals are "still a long way off, but hopefully, academic medicine." . . . **Michael R. Theerman** graduated from Tufts Medical School last May. Mike, who is married and has two children, began his internship in July in Worcester. . . . **Regan J. Fay** reports that **George E. Biehl**, **William C. Michels**, and **Chris D. Thurner** came to Washington, D.C., last May to help him celebrate the receipt of his J.D. degree from George Washington University Law School. Regan is now in the middle of a two-year clerkship for Judge Miller on the U.S. Court of Customs and Patent Appeals. A Paper of Regan's "Conception of a Chemical Compound—Is a Mental Formation of Utility Required?", was published in the August 1974 issue of the *Journal of the Patent Office Society*. (I've got a copy of the paper, if any of you would like to see it.) . . . **George Biehl** is now teaching in Bangkok and **Chris Thurner** is stationed at Ft. Carson, Colo.

Srikanth Rao received an M.S. in business administration from Pennsylvania State University in August. . . . Alan Chapman (whose class affiliation apparently has the Alumni Office mystified) took a trip to Germany and Austria during July and August. For further information on his exploits at Yale, see November's Class of '71 column. . . . **Steven J. Gould** was recently appointed Assistant Professor of Pharmacognosy in the School of Pharmacy, University of Connecticut. . . . Joel I. Seiferas, '69, has been appointed Assistant Professor of Computer Science at Pennsylvania State University. He recently received a Ph.D. in computer science from the Institute. Joel, who was a National Science Foundation Graduate Fellow and a member of Phi Beta Kappa, is a member of the Association for Computing Machinery, American Mathematical Society, and the Society for Industrial and Applied Mathematics. . . . **David A. Saar** reports that he recently joined Black and Decker Company in Towson, Md., where he is working in the Advanced Development Department. Dave is getting acquainted with the Baltimore and Washington areas. . . . In September, **Tony Rufolo** started working as an economist, specializing in urban economics, for the Federal Reserve Bank of Philadelphia. He hopes to send his finished dissertation back to U.C.L.A. in the next few months. Tony's wife, Pat, is working on her B.S. at Drexel University now that she has retired as a nurse. . . . That's all for now. At the risk of sounding like a broken record, I ask, once again, that you write and let us know what you're doing. Happy New Year!—**Laura Malin**, Secretary, 82 Munroe St., Apt. 1C, Somerville, Mass. 02143

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I find the most difficult part is writing the Class Review opening statement. After that, the rest flows out like water from a leaky aquarium. (Sorry for the nauseating jokes, but this time it was for my aquarium—I promised to mention it in this column.)

Before mentioning anything else I should first explain a matter that I feel is important. Although this issue is published and distributed in January 1975, this column is written in November 1974. For every issue of *Technology Review* the Class Review is due approximately two months prior to publication. What that means is this: what you send me will be printed, but that could be two to three months from when you sent me the letter; and what you read is (therefore) two to three months late news—a fact that (sometimes) should be taken into account. So, what you write (or whatever you send) will be printed. You are part of the Class of 1974 and you deserve to be mentioned here—make sure that you are. If you do not receive *Technology Review* (assuming you are reading a friend's copy), then let me know and I'll fix the mistake. Now the news.

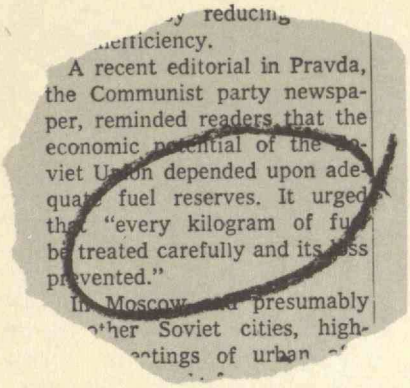
Scott Shlecter is in Boston working for Bain and Company, a management consulting firm. He has been accepted to Harvard Business School, but he will stay at his firm. He plans to start his school career at the Business School in September, 1976. . . . Right now **Mark Cohen** is a medical student at Columbia College of Physicians and Surgeons. He writes: "It's not a bad life in New York because this is where it's all happening." A bit of advice—or a casual observation?

Another person in New York is **Naomi Markovitz**, who writes "I work at Manhattan Day School where I teach algebra to eighth graders and run the Mathematics Laboratory for grades one through six. In the math lab students discover and/or concretize mathematical concepts through the use of manipulative apparatus and ditto sheets." I remember ditto sheets, don't you? Memories of public school. . . . Well, back to the news. **Steve Pearlman** is currently a metallurgical engineer for Wyman-Gordon Company in North Grafton, Mass. . . . **Bill Donner** is also in Massachusetts working for Digital Equipment Corporation as a systems programmer.

I just received a letter from **Chris Demain** who is living in Boston—the Brighton part. This is an actual last-minute item—I received the letter the day before the deadline and rushed in with this extra copy the next day to the *Technology Review* office.) Chris is currently attending M.I.T. Sloan School and expects his S.M. in 1976. In January 1975 (as you read this column!) Chris will be married to Joyce Lerner, another M.I.T.er, who will have an S.B. in Math by December, 1975. But he is even busier than that. He writes: "I have a part-time job with a small software firm in Cambridge and spend most of my time setting up Joyce's and my apartment or tooling." Sounds like a hard worker. Just thinking about it gets me exhausted!

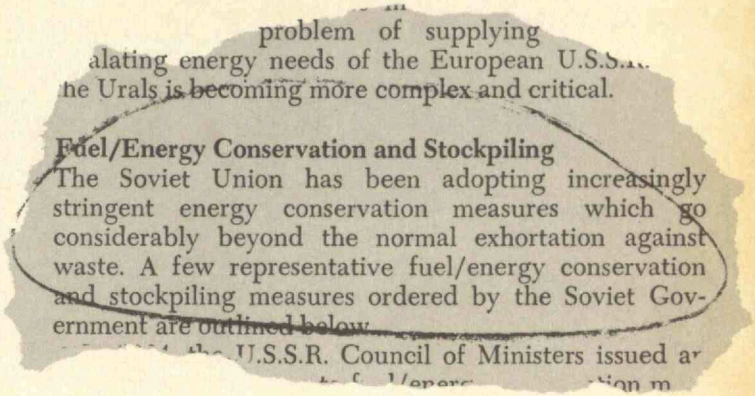
I was about to list the unemployed classmates, but decided not to depress any more than I have to. A bit of advice: if jobs in your area are scarce, then try a federal research and development grant—M.I.T. does it all the time, so why not you? Just start your own company and work on energy, the environment, or fly-wheels. If not, you can become a rock/folk singer. All you need is a good manager. If you can't sing or play an instrument, all the better—a new gimmick is what people want. You can always become a professor. And on that note, I leave you till next time.—**Dennis Dickstein**, Secretary-Treasurer, 23 Howard St., Cambridge, Mass. 02139

Keeping ahead of the Times



reducing
inefficiency.
A recent editorial in Pravda, the Communist party newspaper, reminded readers that the economic potential of the Soviet Union depended upon adequate fuel reserves. It urged that "every kilogram of fuel be treated carefully and its loss prevented."
In Moscow and presumably other Soviet cities, high-
meetings of urban

The New York Times
November 20, 1974



problem of supplying
alating energy needs of the European U.S.S.R.
he Urals is becoming more complex and critical.

Fuel/Energy Conservation and Stockpiling
The Soviet Union has been adopting increasingly stringent energy conservation measures which go considerably beyond the normal exhortation against waste. A few representative fuel/energy conservation and stockpiling measures ordered by the Soviet Government are outlined below.
the U.S.S.R. Council of Ministers issued a
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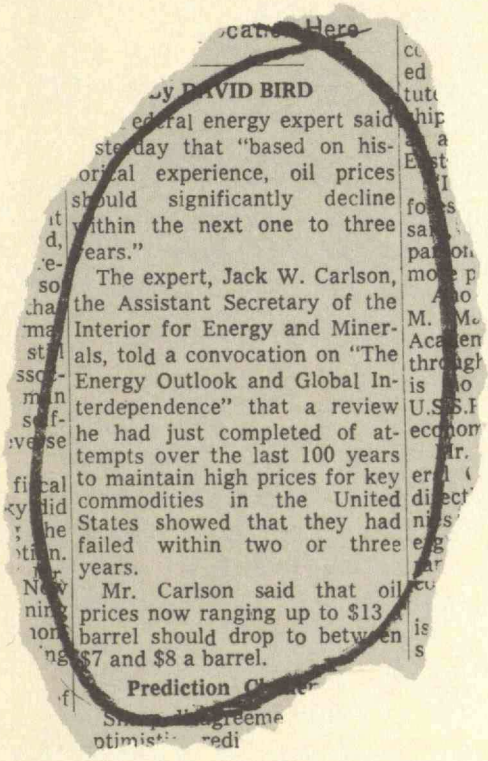
***Technology Review*, October/November 1974**



Here
By DAVID BIRD
federal energy expert said yesterday that "based on historical experience, oil prices should significantly decline within the next one to three years."
The expert, Jack W. Carlson, the Assistant Secretary of the Interior for Energy and Minerals, told a convocation on "The Energy Outlook and Global Interdependence" that a review he had just completed of attempts over the last 100 years to maintain high prices for key commodities in the United States showed that they had failed within two or three years.
Mr. Carlson said that oil prices now ranging up to $13 a barrel should drop to between $7 and $8 a barrel.
Prediction
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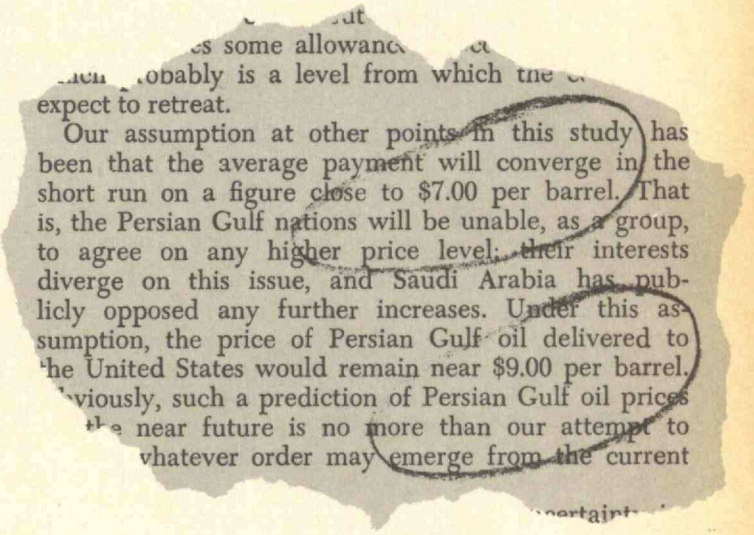
optimis
redi

The New York Times
November 21, 1974



s some allowanc
ich probably is a level from which the
expect to retreat.
Our assumption at other points in this study has been that the average payment will converge in the short run on a figure close to $7.00 per barrel. That is, the Persian Gulf nations will be unable, as a group, to agree on any higher price level; their interests diverge on this issue, and Saudi Arabia has publicly opposed any further increases. Under this assumption, the price of Persian Gulf oil delivered to the United States would remain near $9.00 per barrel. Obviously, such a prediction of Persian Gulf oil prices
the near future is no more than our attempt to
whatever order may emerge from the current
certain

***Technology Review*, May 1974**

Technology Review

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Carl N. Hodges:
With only water and elemental protection, the desert has been made to yield crops of surpassing quality and quantity

Kenichi Ohmae:
A key factor in Japanese prosperity has been a unique, self-perpetuating cycle of dependence; can that cycle now be broken?